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The Savannah River Levee, Augusta, Ga.

By Nisbet Wingfield*

SYNOPSIS—An eleven-mile earth levee, with reinforced-concrete bulk-head gates and retaining wall is being built by the city of Augusta from a point just above the city to and for three miles through the city and to a point eight miles below the city where it meets a bluff. Before describing the levee the causes which demand its construction are given.

The Savannah River heads in the Blue Ridge Mountains between Tennessee and North Carolina and flows southeasterly to the Atlantic Ocean. Located 202 miles from Savannah, or 220 miles from the mouth of the river, is the city of Augusta. From the head waters to Augusta, the river and its tributaries flow through a mountainous country, the highest point being 4600 ft. above sea level and the elevation at Augusta being 103 ft. Augusta is at the foot of the hills or "fall line" and from this point to the ocean the river flows through the coastal plane.

The total drainage area above Augusta is 7295 sq.mi., the rainfall from which quickly finds its way to the main stream. The extreme low flow of the river, at Augusta, during a record of 40 years, is 2300 cu.ft. per sec.; the ordinary low flow is 5000 sec.-ft. In times of greatest flood the river has a volume at Augusta of 300,000 sec.-ft. When these floods come, the water is kept within or near the river bank, on account of the high hills on each side, until it reaches the city of Augusta, which is located at the foot of the hills on the plane on the Georgia side of the river. On the South Carolina side, the foothills continue for some miles below the city, but on the Georgia side they stop abruptly at the upper limits of the city and there is no high ground until a point eleven miles further down is reached. This makes a gap through which the flood waters pour after the river reaches the stage of 34 ft., and the flow is directly through the business and manufacturing section; the flow passing to the low ground south of the city. On these occasions the entire business district and many miles of residence streets are under water, the depth of the overflow varying from 3 to 15 ft., according to locality. The loss of life and property at times have been tremendous. As the water flows in along the entire river front of the city, which is three miles, and also backs in from below the city, the only feasible method of protection was by a levee to be started at the high ground just above Augusta and continue down the river a distance of 11 mi. to a natural bluff on the river bank.

The city owns a water-power development which fur-

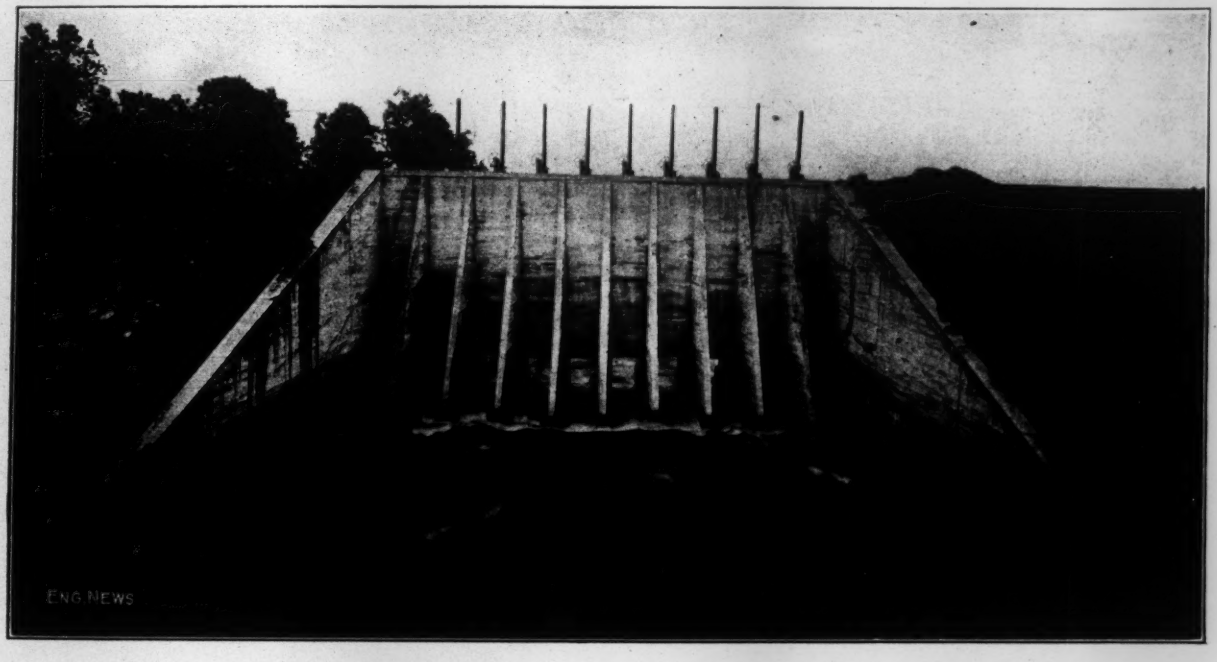

Fig. 1. Reinforced-Concrete Bulkhead and Gates at Hawks Gully, Augusta Levee
(Height, 49 ft. above foundations. There are 10 openings, each 5x15 ft. high in the clear. View taken on land side.)

*Chief Engineer River and Canal Commission, Augusta, Ga.

FIG. 2. REINFORCED-CONCRETE BULKHEAD, WATER-CONTROL

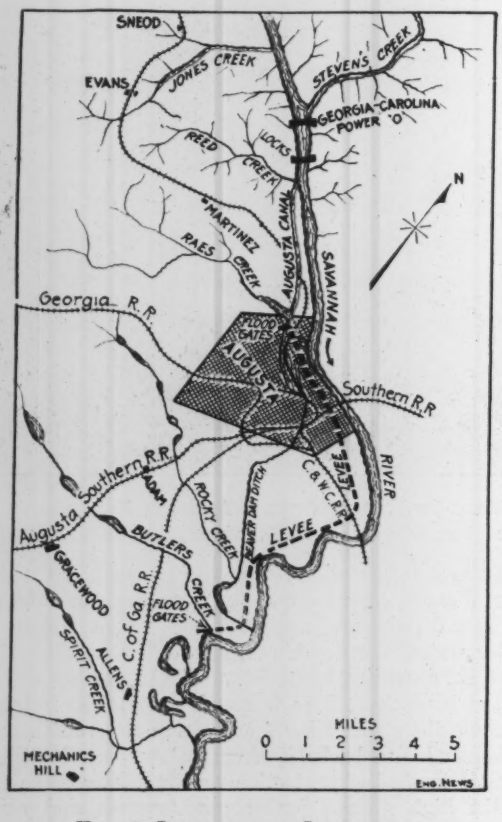

FIG. 3. LOCATION OF LEVEE FOR THE PROTECTION OF AUGUSTA, GA.

nishes all mills in the city with water power. This development was made 35 yr. ago before the hydro-electric method was thought of. There is a diverting dam (see map, Fig. 3) across the river seven miles above the city and a canal 150 ft. wide leads from this into and through the corporate limits of the city. The levee starts at the bank of this canal just above the city. At this point, emergency gates (Fig. 2) will be put in the canal to cut off the flood water from that direction if the river should back into the canal, as it has done during periods of high water. From this point the levee will go downstream, following closely the river bank, going between the mills and various other industries along the river bank and the river proper.

The ground on which the levee is being built was occupied by the railroad terminals, numerous mills and factories and a number of residences, all of which were bought by the city and moved to new location.

As already stated, the maximum flood passing Augusta has been 300,000 sec.-ft. We have had four floods almost identical as to volume, but the record of rainfall over the watershed indicates that each of the several floods came from heavy precipitation on only a portion of the watershed and in no instance from the same area.

In determining the height of the levee we provided for heavy rainfall over the entire watershed, which would bring the discharge at Augusta up to 400,000 sec.-ft., and the entire structure is designed to safely withstand this amount of flood.

The general construction of the levee is an earth fill, sloped 2½ to 1 on the river side and 2 to 1 on the land side, except at certain points where there was not sufficient space between the mills and the river. At these points reinforced-concrete retaining walls have been built

GATES AND LOCK IN AUGUSTA POWER CANAL AT HEAD OF LEVEE

on the land side and regular earth slopes carried out on the river side. The height of the embankment varies from a maximum of 46 ft. to a minimum of 10 ft. After passing through the city limits the levee will run eight miles downstream. The location is through hay farms, cotton fields and swamps.

At points where streams are crossed there have been constructed reinforced-concrete bulkheads with steel gates

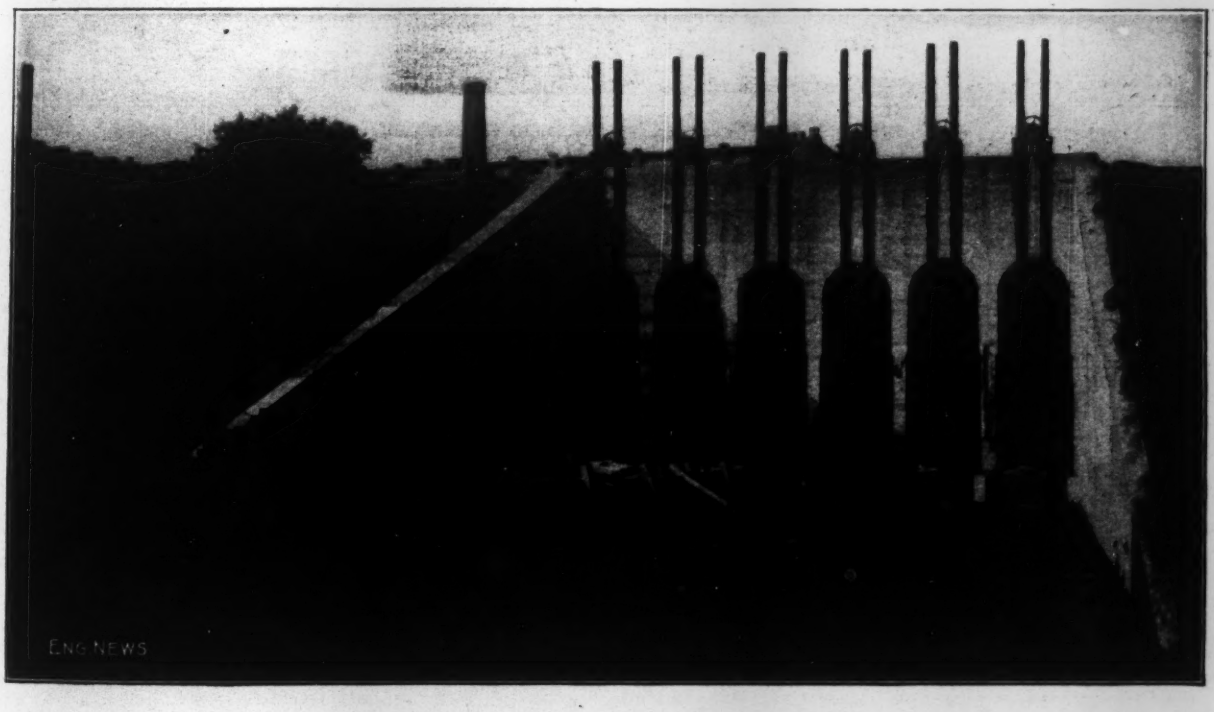

FIG. 4. SIBLEY MILL BULKHEAD AND GATES

(Of reinforced concrete, 59 ft. high above foundations. The openings are 8x20 ft. in the clear. View taken from river side.)

(see views, Figs. 1 and 4). All bulkhead foundations were carried to solid rock.

At the two bridges crossing the Savannah River, additional spans have been constructed on the Georgia side of the river landing on top of the levee. Proper approaches have been constructed by raising the roadway. At the point where the Southern Railroad is crossed, a gate will be put in with an elevation 6 ft. above the track. The C. & W. C. R.R., two miles below the city, will be raised to meet the level of levee.

The fill through the city will require 800,000 cu.yd. of earth, all of which is being hauled in by train from a borrow pit outside the city limits. From the eastern city limits to Butler's Creek, the fill will be made of earth borrowed along the line of the fill and the construction will be with scrapers. The slope along the city front is being paved with stone. That portion of the levee outside the city limits will be planted in Bermuda grass.

The pavement which is now being constructed is 18 in. thick, there being placed first a layer of crushed granite 6 in. thick on top, on which are laid stone slabs 12 in. thick, making a total of 18 in. This pavement was started at the bottom of the river at the toe of the natural bank where a trench running parallel to the bank has been dredged 10 ft. wide to rock bottom. In this has been dumped heavy stone weighing from 50 to 10,000 lb., the mass being brought up to an elevation that will intersect with the bank slope. From the shore side of this trench rock, the pavement is started and carried up over the entire bank and levee without a break, to the crown of the levee.

The concrete retaining-wall, at the Riverside Mills, 900 ft. in length, is carried on piles. Beneath this wall, sheet piling has been driven 27 ft., or practically to a level with the bottom of the river, in order to cut off a strata of running sand. This covers a space 900 ft. in length.

The sewerage and drainage systems of Augusta have heretofore all entered the river at various points along the three-mile river front. We have 12 of these outfalls. To take care of the drainage during periods of high water without the necessity of constructing gates, it was determined to construct a new outlet emptying into the river eight miles below the city, at which point the flood level is not sufficient to back the water into the city. To accomplish this a drainage ditch 30 ft. wide and of sufficient depth has been constructed from the city to the river eight miles below. A large intercepting sewer is being constructed which will take all of the water passing out of the 12 outfalls and deliver it to this drainage ditch beyond the southern limits of the city. This will eliminate all openings through the levee, except at the large bulkheads at Sibley Mill, King Mill, Hawks Gully and the Southern Railroad. This sewer is being constructed of reinforced concrete, because at times there will be back pressure.

The total cost of the work, including right-of-way and paving the bank on the river side, will be approximately $2,500,000. The work has been divided into different contracts, varying in amounts from $50,000 to $250,000, so that firms of moderate means can bid. In this way we are saving at least 10% of the estimated cost. Five contractors have completed jobs aggregating $800,000 and other contracts are being let from time to time. A considerable part of the contract work was done by A. J. Twiggs & Son, of Augusta. Everything is going with a rush and we hope to have the city protected from all but highest floods by Jan. 1, 1915, and fully protected from all floods by Jan. 1, 1916.

Approximately $1,000,000 has been spent on this levee so far and recently the city voted $750,000 additional. The work is being done under a special board, called the River and Canal Commission. The writer is Chief Engineer and J. E. Parker is Principal Assistant Engineer of the work. The plans for the bulkhead were made by Charles A. Maxwell, of Augusta.

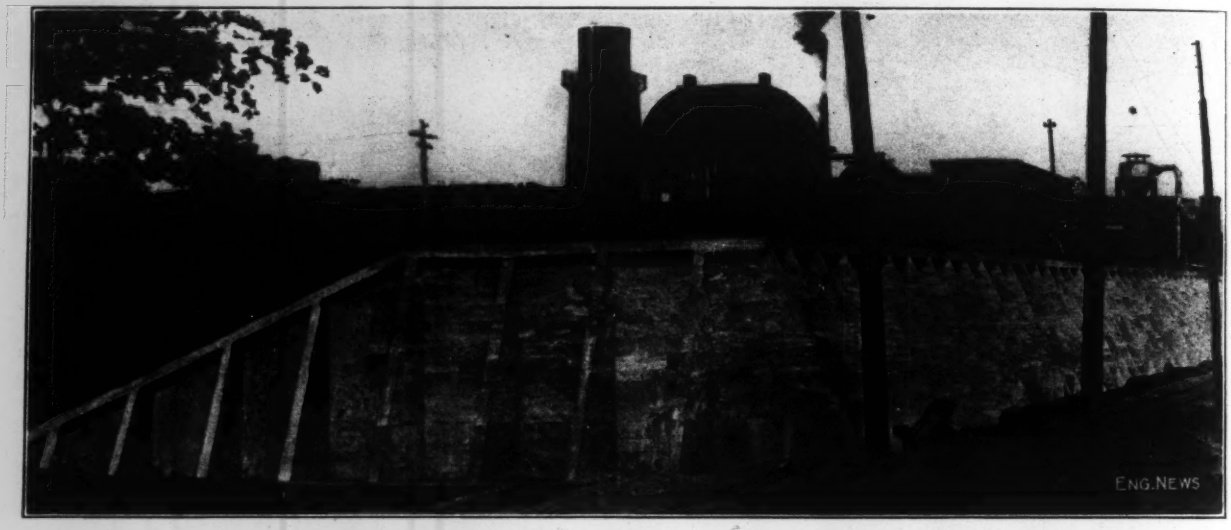

FIG. 5. REINFORCED-CONCRETE RETAINING WALL AT RIVERSIDE MILLS
(The wall is 24 ft. high and is supported on pile foundations.)

A Vibration Measuring Instrument, known as the Fullarton Vibrometer, was described in the London "Engineer" of July 10. The purpose of the instrument is to measure vibrations in rapidly moving machines, such as turbines or electric generators. The principle of the instrument is the tuning of a metallic reed until its responds to the vibration which is to be measured. This does away with the necessity of obtaining some fixed abutment near the machine to be measured.

Water-Level of the Great Salt Lake

By J. Cecil Alter*

The maximum stage of the Great Salt Lake, Utah, was reached June 10 to 15, 1914. It exceeded the crest stage of 1913 by 6 in. Last year the highest stage occurred during the latter part of May, and in 1912, during the last week in June, which is the average time for the high water to occur. The lake is averaging higher now than

Fig. 1. East End of 11-Mi. Trestle of Southern Pacific Ry.

at any time since the middle eighties, long before the Saltair Beach bathing pavilion, near Salt Lake City, was built, and which stands now about 1200 ft. out in the lake in five or six feet of water.

The oscillation of the lake, annually, amounts to about 1½ ft., though yearly oscillations have been as great as 3.6 ft.—from November, 1906, to July, 1907—and oscillations as small as one foot have been noted within the 11-yr. period of careful observations.

Beginning in June, the stream flow into the lake is being more and more utilized for irrigation purposes, and the stream supply from mountain snow is being more and more depleted, so that the amount of water flowing into the lake diminishes very greatly, besides this being the period of least rainfall over the Great Basin region. The loss of water from the lake by evaporation is greatest beginning in June, because of the increased heat, the greater number of hours of sunshine per day, and the increased velocities of the wind blowing over the lake.

These influences cause the lake to fall until the early half of January, each year, at which time the average wind velocities have lessened greatly, and other evaporation factors have become greatly lessened. This period of falling water usually covers about seven months. The rise takes place usually in a little more than five months. The greatest amount of precipitation over the Great Salt Lake watershed occurs in the spring; and with the melting snows and consequent rising streams, of March, April and May, the lake makes rapid rise to its crest stage.

The Engineering Department of the Oregon Short Line R.R. has kept a record of the semimonthly gage readings of the lake at Midlake station on the Southern Pacific Co.'s trestle, and at Saltair Beach, and of the rainfall over the contributory watersheds, together with the stream discharges into the lake, and the amount of snow accumulating and remaining in the mountains, as determined from Weather Bureau reports and bulletins.

The railway companies crossing the lake, both in the middle and at the southern extremity, are very much interested in the lake fluctuations because of the millions of dollars' worth of grade, trestle, track and improvements in the lake, for, not only do they wish to know where the water line will be on the grades and trestles, but stormy weather is much more to be feared when the lake is high than when low, as the wave action is much more serious, and wind tides are more disastrous.

About 16 mi. of the Great Salt Lake cutoff of the Southern Pacific Ry., between Lucin and Ogden, Utah, is over dry lake bed; 11 mi. is wood trestle across Great Salt Lake (Figs. 1 and 2). The first piles for the construction reached the lake in July, 1902. The rate of progress reached as high as 1140 ft. of trestle per day. Work was carried on from both ends and the juncture was effected Nov. 13, 1903. The construction of the Great Salt Lake cutoff is described in full in Engineering News, Feb. 27, 1902, p. 175 and Nov. 27, 1902, p. 442.

The resort companies in times past have found it necessary to rebuild or remove many expensive bathing houses and piers because of the changes in level.

The salt harvesters are also interested because their dirt dikes along the shore, inclosing the evaporating ponds, are sometimes endangered in high-water times, when strong wind tides are produced in wind storms of long duration.

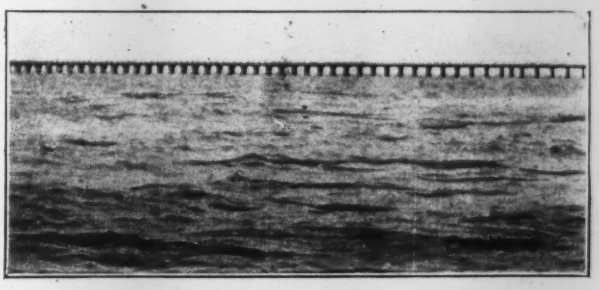

Fig. 2. Portion of the 11-Mi. Trestle

They are also interested in the probable depth of the water because the density of the brine has varied from about 25% to 20% solids, during the past 11 yr. The salt contents of the lake remains about the same, though it is diluted in time of high water, requiring the pumping of more water into the ponds, and longer waiting for it to evaporate, to obtain the same amount of salt.

*United States Weather Bureau, 1103 Boston Building, Salt Lake City, Utah.

Ohio Highway Facts—Ohio has (approximately) 83,700 miles of public roads outside of municipalities; 28,413 miles are improved. Of 11,000 miles of streets within the limits of the various municipalities, 6360 miles are improved. Some 573 miles of road improvement have been contracted for from the organization of the State Highway Department, in 1905, to November, 1913; 373 miles were contracted for during the last three years—up to and including Nov. 15, 1913; 103.7 miles of additional improvement have been contracted for from Nov. 13, 1913, up to the present time. Petitions had been filed for 7047 miles of improvement up to Jan. 1, 1914. The State Highway Department expects to improve approximately 500 miles of roads before the close of 1914. More than 55,260 miles remain unimproved. Ohio ranks third among the states in the percentage of public roads improved. Concrete roads have been built in 29 of the 88 counties of Ohio. Brick roads have been built in 39 counties. Cuyahoga County has the greatest mileage of brick roads (172.3). Huron County has the greatest mileage of concrete roads (16.0).—[From the June "Ohio State Highway Department Monthly."]

Washington Street-Cleaning Field Methods

By J. W. Paxton*

SYNOPSIS—This article is a continuation of the preceding one by Mr. Paxton in Engineering News *of July 9, 1914, p. 58, which described the cost-keeping methods. The following article describes in detail the field methods—the hand patrol; the machine-broom work; squeegee washing; flushing; suburban street cleaning and alley cleaning. Snow removal is briefly described. The stables and supply and repair divisions are included.*

The territory taken care of by the Washington Street Cleaning Division includes all of the streets in the city, certain suburban sections with gravel, macadam or unpaved streets and an extensive alley system.

The city is divided into two sections with approximately the same amount of cleaning in each. Almost in the center of one of these sections is a stable, the main storeroom, and repair shop; a second stable, auxiliary storeroom, and repair shop, are nearly in the center of the other section.

Fig. 1. Hand Patrol Gang at Work, Showing the Pan-Scraper, Hand Machine, and Bag Carrier Used in Washington; the Wagon Is Collecting the Filled Sacks

To meet the different conditions and requirements, cleaning is of several classes, such as Hand Patrol, Machine-Broom Cleaning, Alley Cleaning, Suburban Cleaning, Flushing, Squeegeeing, Oiling and Snow and Ice Work.

Hand Patrol

The hand-patrol area consists, at the present time, of approximately 2,856,000 sq.yd. or about 57% of the total paved area of the city. It includes practically the entire business section and considerable residential territory adjacent thereto.

Sections—This area is divided into five sections of from approximately 409,000 sq.yd. to 810,000 sq.yd. Each section is under a foreman with a force ranging from 32 men and 2 wagons to 57 men and 3 wagons, the total force employed being 221 men and 13 wagons. The average area per man is about 13,000 sq.yd., which is somewhat larger than reported for other cities, probably due to the frequent washing given the streets, to the fact that Washington has very little commercial traffic, and that men are employed strictly on merit. Each gang may cover its territory several times during the day, but the area is only credited once for a full day's work; one-half for one-half day's work, etc. At the end of the month, the total area credited is divided into the total cost charged, for each gang, giving the unit cost.

Subsections—Each foreman divides his large section into subsections to be worked by one, two, or five men. The area per man is dependent on the amount and character of traffic, the presence of car tracks, the sanding of car tracks, kind and condition of pavements, grade surrounding population, vicinity of unpaved streets, and the force available.

The one-man section is generally located in the suburbs where little dirt accumulates, and a large territory may be covered; the man sweeps, pans and sacks the dirt as he goes along. The two-man section is standard; the more active man uses a panscraper, broom or hand machine and deposits the dirt in the gutters; his partner with a bag carrier, collects the material so deposited, and sweeps the gutters clean.

The five-man section is used on broad, heavily traveled streets, where the area is large in proportion to the gutter length. The method here employed is similar to that on the two-man section; two men with bag carriers collecting the dirt deposited in the gutters by the other three.

Section Maps—The original development of the subsection is left to the foreman. The limits of each subsection and the number of men employed are reported to the office where the areas of each subsection and the areas per man are computed. This information, together with

*Superintendent of Street Cleaning, Washington, D. C.

the amount of dirt collected per man, is plotted on a map, which is studied and rearranged in the effort to obtain a uniform task for each man.

Relation between Area and Dirt Collected—The relation between area and dirt collected is theoretically an inverse ratio; other things being equal, that subsection showing the greatest area per man should accumulate the least dirt per 1000 sq.yd., while the minimum area per man should show a maximum of dirt collected per 1000 sq.yd. Frequent conferences between the office force and foremen are held to make and receive suggestions as to the best size of subsections.

The area of the subsections established, ranges from 6000 sq.yd. in the market section to 52,000 sq.yd. in the lightly traveled residential sections. The amount of dirt removed per day per bag carrier runs as high as 200 sacks during leaf season, and again as low as 8 or 9. The average per bag carrier per day lies between 10 and 20, each sack holding about 2 cu.ft.

Hand Patrol vs. Machine Work—Experiments have been made as to the relative cost of machine work and hand patrol. It was found, in most cases, that the streets were kept in better condition, when the same amount was expended on hand patrol as on cleaning by machine brooms every other day.

In hand-patrol work, where the traffic conditions are variable, the distribution of the men can be increased or diminished accordingly. The greatest attention is given to the portions of the streets which need it the most, and the attention is continuous, the streets being just as clean at one time as at another.

With machine-broom sweeping, however, the entire section and every portion of each street must receive the same amount of sweeping. The streets present a good appearance immediately after the passing of the brooms, but become more unsightly than in hand-patrol work before the next cleaning, as the interval is much longer.

The machine broom raises so much dust that heavy sprinkling is required; the fine dust mixes with the water into mud, which is smeared on the street by the broom, and on drying, turns back to dust. The brooms only sweep the coarser particles and many of these are thrown over the broom by centrifugal force, back to the pavement again.

The policy of the division has therefore been to curtail the machine-broom area, whenever possible, in favor of the white wing work, supplemented, as funds are available, by washing in the more important and heavily traveled portions of the city.

Small Power-Operated Brooms—In hand-patrol work, a large proportion of the energy and time is consumed in traveling from one dirty portion of a street to another, particularly after the streets have been cleaned in the morning, or on streets where the traffic is light.

In an effort to increase the efficiency of this work, experiments have been tried with a light motor-driven tricycle, operated by one man. The broom is rotated by the engine, when lowered to the pavement, so as to brush the dirt into a pan receptacle; but it is disconnected, when raised, for traveling. A scraper in front of the broom loosens dirt which is stuck to the pavement.

This machine deposits the dirt in the gutters, and white wings equipped with bag carriers collect it as well as clean the gutters. The machine is still in the experimental stage, but the results obtained have been very encouraging. It may be possible eventually, by the use of a conveyor, to lift the dirt into bags or cans carried on the machine, doing away with hand-patrol work entirely.

Supervision of Hand-Patrol Work—Motorcycles have been used to reduce the overhead expense of the hand-patrol work; three of the foremen supplied with these machines, take the places of four using bicycles, and they supervise a somewhat larger area. It is expected that another rearrangement of the white-wing area will shortly be made and the supervisory force reduced to four men, each equipped with a motorcycle, where six men with bicycles were formerly required. The foremen are very well satisfied with the machines, each making an average of from 50 to 80 miles per day.

Hand-Patrol Equipment—The equipment used on hand-patrol work consists of bag carriers, hand machines, pan scrapers, bamboo push brooms, sacks, shovels, sprinkling cans, etc. The dirt collected is placed in sacks which are collected in wagons manufactured by the Department. The question of building underground pits to hold the accumulation of street sweepings is being considered, but the initial cost would be so large that money is not available at the present time for this purpose.

The hand machine consists of a revolving bass broom mounted on wheels between two metal boxes, its action being exactly similar to that of a carpet sweeper. It is especially useful for removing fine dust on smooth pavements, but pan scrapers are found to be more generally useful.

Machine-Broom Cleaning

The machine-broom area consists of approximately 2,000,000 sq.yd. or 43% of the paved area of the city; this territory is almost entirely residential. Some of the streets with heavy traffic are cleaned daily, others with very light traffic are cleaned three times in two weeks, while the majority are cleaned every other day.

The force employed in this work consists of two gangs of one sprinkler, three machines and four carts, and one gang of two sprinklers, six machines and seven carts, sufficient broom men being provided to pile the dirt swept to the gutters by the machines, the number of broom men depending on the general conditions of the territory under attention.

Supervision of Machine Work—The supervisory force maintained for this division of the work consists of four foremen; one with a buggy for each three-machine gang, and two—one with buggy and one with motorcycle—for the six-machine gang.

Previously, four gangs of three machines were used, but it was found that while the machines were being closely observed, the cart men were practically left to themselves, it being impossible to follow both the machines and carts and make the necessary trips to the dumps. Two of these gangs were, therefore, combined, the machines being put in charge of a foreman with a buggy, while the carts worked under the direction of a second foreman with a motorcycle. This arrangement has not materially increased the yardage cleaned, but the foreman with the motorcycle has been able to give such attention to the carts that his force has been reduced from eight to seven.

Methods of Operation—The ratio of one sprinkler with three machines was found by experiment with odometers in connection with the cost keeping to be the most

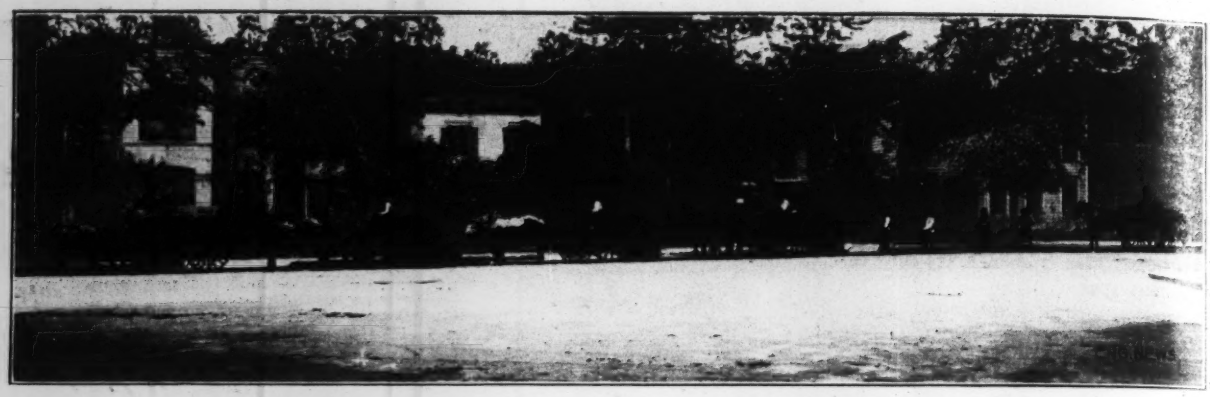

FIG. 2. MACHINE-BROOM STREET-CLEANING GANG; WASHINGTON, D. C.

efficient for local conditions. Under the contract system, the organization of the gangs varied from one sprinkler with three or four machines to two sprinklers with five machines. These different combinations were tried out and it was found that higher unit costs were obtained with the one-three than with the one-four combination; but in the latter case the distance traveled by the sprinkler horses, in order to keep up with the machine, was prohibitive. The one-three combination gave a uniform distance of about 25 miles per day, for both machines and sprinkler, while the two-five combination favored the sprinkler as to distance traveled and gave still higher unit costs.

The mode of operation followed is for the sprinkler to precede the machine some little distance, the valves being popped so that only enough water escapes to lay the dust and at the same time not cause mud. The machines follow each other, overlapping slightly, each street being swept from the center toward the curb.

It takes about two full working days for each gang to sweep their section. Sweeping must be done continuously from the time of leaving the stable until the return and in order to do this one side of the running street is swept going out, leaving the other side to be swept coming in. After reaching the territory, the order of sweeping is arranged as seems best in the judgment of the foreman at the time. An effort is made, however, to reduce the amount of turning to a minimum and always to sweep toward the dumps.

Each machine averages about 85,000 sq.yd. per day; the records, however, show spurts as high as 100,000 sq. yd. It should be noted that this class of work is harder than any other on live stock, although the draft is light, possibly due to the fact that the animals have no breathing spells or variation in work.

In leaf season, no additional machine work is required. The carts, however, have a much greater bulk to handle although the additional weight is very little. To care for this, all machine carts are provided with side and end boards of light weight, which fit on the flareboards, increasing the capacity of the cart about 2½ cu.yd. After leaf season, these tops are removed and stored for the next year.

SQUEEGEE WASHING

The area covered by the squeegees comprises about 1,766,000 sq.yd. of the smoothly paved streets in the white-wing section, being about 64% of the total white-wing area. The force employed on this work consists of three gangs, each under a foreman, and composed of one

FIG. 3. SQUEEGEE STREET-CLEANING GANG; WASHINGTON, D. C.

sprinkler and three machines, the territory being covered about twice per week. During the winter months, this force is decreased to two gangs of one sprinkler and three machines each, the interval between washings being correspondingly increased.

METHOD OF USING SQUEEGEES—The ratio of the number of machines to a sprinkler has been worked out in a manner analogous to that described under machine-broom cleaning, this combination proving the most economical. When filled, each squeegee carries as much water as an ordinary sprinkler, the broom must be dragged along the pavement and also revolved in the opposite direction to this motion; so it has been found advantageous to use three horses with each squeegee in the battery which works in a hilly section of the city.

Squeegeeing about twice per week almost entirely eliminates a fine scum which becomes plastered to the pavements, particularly sheet asphalt, which is not apparent when the pavements are dry but rises up in a thin sheet of mud when moist, making the pavements very slippery. This and fine dust cannot be removed by the hand cleaners.

Washington having a comparatively high-pressure water system, the machines used are of the hydraulic compressed-air type, and on the streets which are dirtiest will clean approximately their own width. Each filling is sufficient for a swath of about 500 ft. in length.

METHODS OF OPERATING FLUSHING MACHINES—The flushing machines are operated like the squeegees, each machine taking up the wave from the one in front and forcing it 7 or 8 ft. further toward the curb. Operated in this way, they are very efficient, but the cost of cleaning is about three times as much as squeegee work, so flushers are only used on streets unsuitable for squeegees.

It has been observed, in some other cities, that streets are said to have been flushed if one trip through has been made with a single flusher, and from the low cost of flushing reported from other cities, it is assumed that this is the method there pursued. Experiments here, indicate that this amounts to little more than sprinkling, although the pressure developed from the hydrant is always at least 45 lb. per sq.in.

Flushing being resorted to only on other than good sheet-asphalt streets, the territory is necessarily scattered

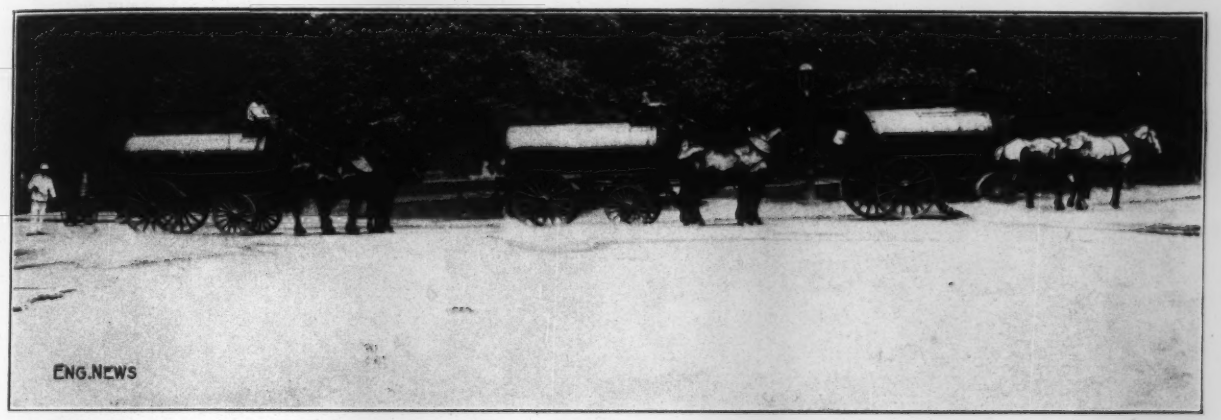

FIG. 4. FLUSHING GANG; WASHINGTON, D. C., STREET CLEANING DEPARTMENT

The sprinkler with the valves wide open precedes the squeegees at some little distance, the object being to thoroughly saturate this scum and soften the dry material on the street for removal by the squeegees. The machines follow each other as closely as possible, each machine receiving the dirt mixed with the water from the machine in front, and carrying it the width of the broom toward the curb.

The dirt deposited in the gutters is collected by the white wings, the cost of the collection being charged to that class of work, squeegeeing being considered an adjunct to the hand-patrol system and the charge for removal made on the theory that, were no washing done, this accumulation would have to be removed by the hand-patrol force.

FLUSHING

The flushing area comprises all worn and block pavements in the white-wing section, the entire territory totaling approximately 300,000 sq.yd. or 11% of the total white-wing area, each street being flushed about twice weekly by a gang of one foreman and three machines, three horses being used in each.

and it is impossible to arrange running streets or eliminate dead travel as is the case with other machine apparatus. The daily task performed only amounts to about 30,000 sq.yd. per machine.

CLEANING AND OILING SUBURBAN STREETS

The suburban territory consists of approximately 1,500,000 sq.yd. of water-bound macadam or unpaved streets. The object of this work is to keep the gutters clean, remove all trash, ravelings and weeds. Two gangs, each having a foreman with bicycle, ten men and four carts are employed.

DUST LAYING—In the fall of 1911, experiments in dust laying were tried on certain suburban streets, with calcium chloride and emulsified oil, instead of sprinkling with water, resulting in the decision to use only emulsified oil in the future.

In the spring of 1912, practically all of the suburban streets were thoroughly cleaned and swept with a sweeping machine, without sprinkling, before an application of oil was made. From then on applications of a mixture of about 1 gal. of oil to 6 or 7 gal. of water, spread in the proportion of approximately $^1/_7$ gal. of the mix-

ture to 1 sq.yd., were made about once every ten days or two weeks, the streets being cleaned with hand brooms previous to each application.

By this method, the dust nuisance was almost entirely eliminated. Less money was spent for sprinkling and oiling than for sprinkling alone during the previous year. Less suburban-street cleaning was necessary, on account of there being less dirt and dust to be removed, and the general appearance of the streets was very much improved.

By the oiling method only enough equipment is required to cover the entire territory about once every ten days or two weeks, while by the sprinkling method it was necessary to carry enough equipment in wet weather to cover the entire territory two or three times a day in dry weather.

Only applications of light or emulsified oil will probably be made in the future, as dust laying and not road maintenance is the object in view, and where heavy oil is used in the city, many complaints are received on account of its being tracked into the houses.

Alley Cleaning

The alley system of Washington comprises approximately 1000 alleys, the majority being wide and well paved, the area amounting to about 1,000,000 sq.yd. The cleaning is done by three gangs, each under a foreman with a bicycle; two consisting of a sprinkler, one-horse sweeping-machine broom, three carts and six laborers; the other being a small hand gang of one sprinkler, three carts and four laborers, cleaning mostly narrow and very dirty alleys.

One-Horse Machine Brooms—After the contract system was abolished (previous to which all alleys were cleaned by hand), it was found by experiment, that many alleys could be more economically cleaned by one-horse machine brooms. A chart of the daily yardage cleaned by two of the gangs, for six months after taking over the contract work, was plotted and studied. The foremen were then called to the office and this chart explained and suggestions invited.

As a result of this conference, entirely new schedules were issued in which the alleys were arranged in an approximate circle. These schedules were put in operation and an immediate increase in area cleaned resulted. Later squares containing alleys were classified as follows: those in which the alleys were paved and could be swept entirely by machines, by machines with one hand shaft, by machines with two or more hand shafts, or by hand; and those in which the alleys were partly paved or unpaved.

Classification Map—On a map of the city, all squares corresponding to the first classification were colored in red, to the second, in green, and so on, using a different color for each classification. Two alley schedules to be cleaned by machines, were then traced out, containing, as far as possible, all the squares in the first three classifications, and another schedule to be cleaned by hand, containing the balance of the squares.

An attempt was made, in each case, to arrange the squares in such order as to minimize the distance from the outlet of the alley in one square to the entrance to the alley in the next. Of course, where hand alleys were isolated and surrounded by machine alleys, they were absorbed in the machine schedule; and machine alleys were, in many cases, included in the hand schedule. The lines on the map representing the movements of the alley gangs have the appearance of a maze but every line has received careful study.

Fig. 5. Suburban Street-Cleaning Gang; Washington, D. C.; for Cleaning Macadam and Unpaved Streets

Snow and Ice Work

While Washington is subject to frequent snow storms, very few of them are severe. The climate is such that during the greater part of the winter, the snow disappears within a few days. The streets are wide and the traffic is not often interfered with. No effort is, therefore, made to remove snow except from a few street and railway intersections and the principal transfer points. The street

railway companies bear a large proportion of this expense.

In case of a snow fall of 2 in. or over, snow plows are sent out early in the morning to open up sidewalks throughout practically the entire white wing and machine-broom area. Later in the day, the gutters are all opened by gutter plows in practically the same territory. Crosswalks and gutters are kept clear, openings made from the crown of the streets to the gutters, and the snow is sometimes transferred to the sunny sides of the streets. The idea is to assist the snow as much as possible to melt, and run off immediately to the sewers, before the water has time to freeze.

FIG. 6. ALLEY CLEANING GANG; WASHINGTON, D. C., HAS APPROXIMATELY 1000 ALLEYS

STABLES

The two stables are both new; they are fireproof even to the extent of having iron stall partitions, rolling steel doors at the larger openings, and sprinkler systems in the feed rooms. They are designed for plenty of light and air; nearly all the horses have windows above their heads. There are electric lights throughout. Both stables are plentifully supplied with washing arrangements, all equipment being washed every night.

Only a sufficient force is employed at each stable to clean the building, to feed, water, and shoe the horses, and to watch at night. The horses and harness are taken care of by the drivers.

DUTIES OF DRIVERS—All drivers must be familiar with the city and trained to their work. Some must use considerable intelligence in routing their machines, and others must load their own carts and wagons. Practically, they must serve two masters, the foreman on the streets and the stable boss in the stables.

Theoretically, however, when the driver satisfies one and not the other, and the case comes to the superintendent, the driver is considered to be under the orders of the stable boss, the team and driver going to the foreman as if it were rented from the stable boss, the foreman returning the whole outfit to the stable and requesting another until satisfied. This is on the principle that the stable boss cannot be made responsible for the horses unless he controls the drivers.

Some diplomacy and good feeling on the part of both foremen and stable bosses is necessary, but very little trouble has been experienced so far, and it seems to be the only solution to a problem which promised to be difficult.

REPAIRS AND SUPPLIES

The foreman of repairs is responsible for the condition of all property, such as buildings, cleaning machines, wagons, carts, harness, etc. The foreman of repairs orders or manufactures all supplies and equipment; and he must correctly anticipate the needs of the division. His work is rarely stationary, for it requires inspection of scattered equipment, the supervision of odd jobs here and there, and experimenting with and perfecting apparatus.

The foreman of repairs is, therefore, furnished with an automobile or hurry-up wagon, arranged as a light motor truck, to carry tools and light supplies. He has under him a shop foreman, who has charge of and remains constantly at the repair shop, a material clerk who attends to the ordering of supplies, and a storekeeper who takes charge of the supplies when received, and distributes them.

Statistics of Steel Production in the United States during 1913 are summarized in Special Statistical Bulletin No. 5, issued by the American Iron & Steel Institute, which succeeds to the work so long carried on by the late James M. Swank. Steel production in the United States in 1913 exceeded all previous records, being 31,300,874 tons. The production was, however, only 50,000 tons greater than in the year 1912. Almost exactly half this steel was produced in Pennsylvania. Ohio came next with 6,700,000 tons; Indiana and Illinois combined produced nearly 5,00,000 tons. The open hearth process of steel production now far exceeds the bessemer in volume of output. Last year the bessemer steel produced amounted to 9,545,000 tons, while the open hearth steel amounted to 21,600,000. The maximum bessemer steel production was reached in 1906, when 12,275,000 tons were produced. This compares with 11,000,000 tons of open hearth steel in the same year. Since then open hearth production has been increasing at a rapid rate, while bessemer has fallen off. The production of crucible steel amounted to 121,000 tons, while 34,000 tons were made in the electric furnace. The alloy steels produced amounted to 714,000 tons. The business of steel founding has had a large development. Over 1,000,000 tons of steel castings were produced last year, which compares with 132,000 tons of steel castings in 1898. Nearly all the open hearth steel made is now made in basic furnaces. Only 1,255,000 tons of open hearth steel were made in acid furnaces. The total number of works manufacturing steel from raw materials is 304, located in 30 different states of the Union and in the District of Columbia and Panama.

A Concrete-Incased Steel Viaduct at Chicago

SYNOPSIS—This article describes the decorative treatment of a plate-girder bridge over a boulevard and parkway, in order to secure an attractive appearance. The exterior girders and columns are covered with concrete, with effective results.

The track-elevation work of the Baltimore & Ohio R. R., in the western section of Chicago, crosses Independence Boulevard, which is a broad thoroughfare connecting two parks and is under the jurisdiction of the West Chicago Park Commission. The boulevard is 250 ft. wide between street lines, and has two 32-ft. driveways separated by 131 ft. of parkway. The railway structure is a plate-girder viaduct, but the park commission required that it should be made of pleasing appearance, subject to its approval, and to meet this requirement the railway company adopted the plan of masking the outside girders and columns with concrete, giving the appearance of a masonry structure. The result has been very satisfactory, as may be seen from the view of the work in Fig. 1.

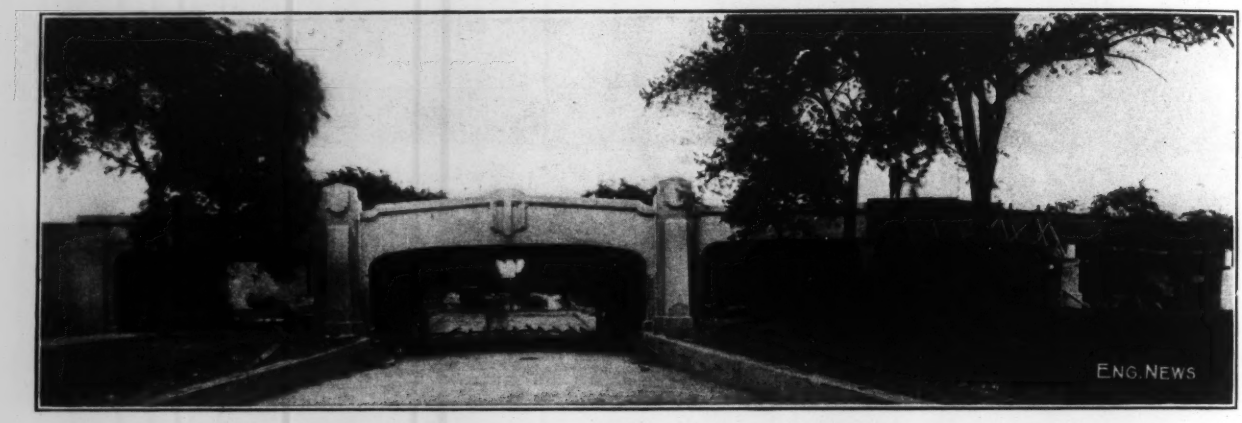

FIG. 1. CONCRETE-INCASED PLATE GIRDER VIADUCT ACROSS INDEPENDENCE BOULEVARD, CHICAGO; BALTIMORE & OHIO R.R.

The park ordinance requires the railway to conform to the following conditions: (1) to maintain the concrete work in good condition; (2) to paint the exposed steelwork an approved light color, and repaint it when required; (3) to construct a tight floor which will prevent water, dirt and oil from dropping through.

The roadways are depressed 2 ft. at the viaduct, and the change from normal grade to the inclined approach at each end of the depression is made by a vertical curve connecting with the grades at points 20 ft. on either side of their intersection. The paving is of asphalt on a 6-in. concrete base. The curbs are of granite, 8 in. thick and 2 ft. deep, except that where the top is more than 1 ft. above the gutter the curb is 5 ft. deep, 12 in. thick at the top and 14 in. at the bottom. The parkway beneath the bridge is covered with 6 in. of crushed limestone, bonded with screenings, and the sidewalks under the bridge extend to the curbs, the grass parking being omitted. The concrete sidewalks, curbing, paving, electric conduit and sewer work were done by the railway company in accordance with the specifications of the park commission.

The structural design was prepared under the direction of F. L. Stuart, Chief Engineer, and W. S. Boutin, Bridge Engineer, of the Baltimore & Ohio R.R. The design of the concrete covering was prepared by F. E. Lockwood, architect, of Chicago. The steel erection and concrete work were done by the railway company, being in charge of L. G. Curtis, District Engineer. The design and construction were under the general supervision of A. C. Schrader, Chief Engineer of the West Chicago Park Commission.

STEEL STRUCTURE

The viaduct is a four-track structure with nine spans. There are two driveway spans 35 ft. c. to c. of columns, separated by five spans of about 25 ft. 7 in., while the two end spans are 30 ft. at the west and 23 ft. at the east end. The headway is 13 ft. at the roadways (which are depressed 2 ft. at the crossing), 8½ ft. in the center to 11 ft. at the sides of the central parkway, and 10 to 11 ft. at the sidewalks (there being a slope of 1 ft. from the abutment to the curb.)

Each of the eight bents has five columns, connected at their upper ends by latticed struts, as shown in Fig. 2. In six of the bents each column is composed of a pair of 12-in. channels (with the flanges inward) and a 12-in. web-plate attached to the webs of the channels by four angles 3½x3½ in. The third bent from each end, however, carries an expansion joint, the structure being thus divided into three sections. In these two bents, each column is composed of two parallel 12-in. web-plates, with four flanges 4x4 in. on each web, and with diagonal lacing bars over the outer angles.

The bents carry five lines of 45½-in. plate-girders, the girder depth being the same throughout and extra strength in the longer spans being secured by heavier

webs and flange angles. The webs of the outer girders have holes for short rods to bond with the concrete covering. The floor system consists of transverse 15-in. I-beams 21 in. c. to c., these being placed just above the bottom chords and secured to the girder webs by angle connection-plates. At the middle and end of each span tresses projecting about 3 ft. beyond the main portion. These buttressed columns are carried up higher than the top of the arch, and are finished with concrete medallions projecting 3 in. from the face.

The main portions of the columns are reinforced with ¾-in. vertical round rods at the corners, wrapped with

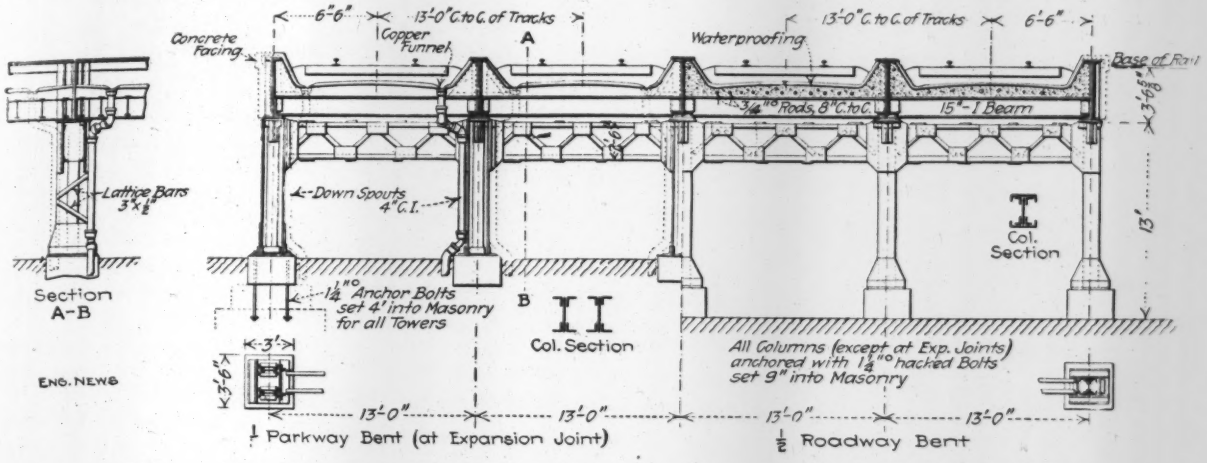

FIG. 2. CROSS-SECTION OF FOUR-TRACK VIADUCT AT CHICAGO; BALTIMORE & OHIO R.R.

are triangular brackets or gusset plates riveted to the girders and to the top of the floor-beams.

CONCRETE DECK—Upon the steel floor framing is a reinforced-concrete deck or slab, the concrete being carried up against the girders so as to form a trough for each track. This deck is of 1:2:4 concrete, reinforced with ¾-in. transverse bars spaced 8 in. c. to c. It is 8 in. thick at the middle and 7 in. at the sides, and drains longitudinally to 4-in. downspouts at the third bent from each end. On the concrete is a waterproofing course consisting of three layers of burlap mopped with hot asphalt, and this is protected by a 3-in. layer of concrete composed of cement and limestone screenings (1:2½). A bed of stone ballast is laid, with ordinary track construction, the ballast being about 6 in. deep under the ties, so that the base of rail is about 12 in. below the top of the concrete facing on the girders.

ABUTMENTS—The abutments are made with vertical instead of battered faces and without the usual coping at the bridge-seat, in order to conform to the architectural treatment of the concrete facing of the bridge. They are of 1:3:5 concrete, except that a 1:2:4 mixture is employed for the bridge seats.

CONCRETE FACING

In the architectural design, the columns and girders on each side of the structure are incased or masked with concrete as noted above. The two roadway spans are made distinctive by heavy columns or piers, by arched lines for the span, and by a simple decorative treatment at the piers and center of span. The bottom of the arch has a fillet of 2-ft. radius at each end, and its center has a rise of 15 in. above the fillets. The top of the arch has a deep coping with a central medallion, these parts projecting about 4 in. from the face, so as to produce an effective appearance due to light and shadow. The concrete columns or piers of these spans project about 16 in. beyond the face of the arch, with sloping but-

wire netting. The buttresses are reinforced with ¾-in rods at the corners, parallel with the slope of the face, and tied into the column with ⅜-in. stirrups. The steel girders are wrapped with wire netting of No. 23 gage, triangular mesh, to hold the concrete and prevent ex-

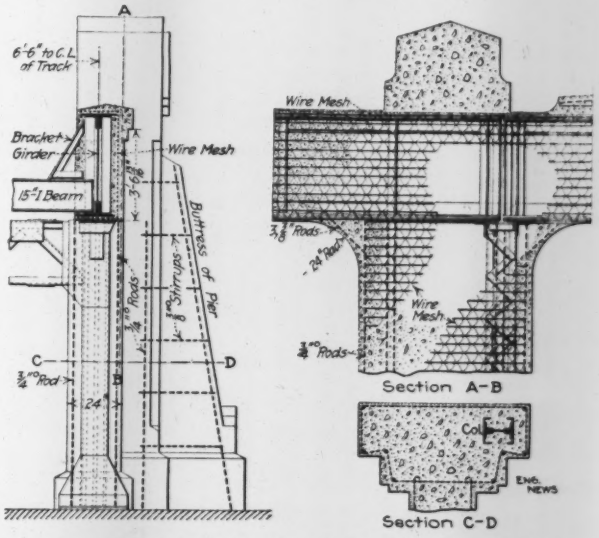

FIG. 3. CONCRETE CASING FOR GIRDERS AND COLUMNS OF THE 32-FT. ROADWAY SPANS OF THE VIADUCT OVER INDEPENDENCE BOULEVARD, CHICAGO

pansion and contraction cracks. Parts of this work are shown in Fig. 3.

The shorter spans have 2-ft. fillets at the junction with columns and a very small rise (about 3 in.) above this. The coping for these spans is the same as for the longer spans, but is carried level across the bridge. The concrete casing of the steel columns is 2 ft. square and unornamented. At the corners are vertical ¾-in. rods, with

wire mesh wrapped around them, and the fillets are also reinforced with bars placed at 45°. The corners and edges of all parts of the concrete work have a ¾-in. bevel.

The concrete used in the columns and arches was a 1:2 mixture of cement and crushed limestone (from ½ in. to dust), no sand being used. Special care was taken to see that all concrete was of the same proportions and consistency, so as to maintain a uniform color throughout. The forms were of dressed lumber. The forms for the concrete covering of the girders were partly hung from the steelwork of the bridge and partly supported from the ground by struts and braces.

The concrete for all columns was placed before any concreting was done on the arches. The larger columns were poured to the top in one operation, a ledge being left at the junction with the arch fillet. The smaller columns were poured to the bottom of the fillets of the fascia arches or girders. The roadway arches were poured separately, as were the sidewalk spans and the parkway spans next to the roadway. The intermediate section of three spans was poured at one time, with an expansion joint at each end, where the expansion joints in the steelwork occur. The concrete was spouted directly into the forms from a mixer mounted on a flat car on the railway. No special facing was used in placing the concrete, a good surface being obtained by thoroughly spading the concrete next to the forms. The use of a small size of aggregate gave a fine texture for the surface, very little difficulty being experienced with pockets or hollows in face.

After the forms were removed and the concrete had seasoned and dried out for a few days, the lips and ridges due to the forms were chipped or filed off with a chisel, coarse file or rasp. The surface was then wetted and rubbed with a coarse carborundum brick until the surface was fairly smooth, a very thin wash of cement and sand being then applied and left to dry. The final rubbing was done with a fine carborundum brick until all the cement wash had disappeared and the surface was smooth and even. All concrete was treated in this manner, including the faces of the abutments. This treatment gives a grayish white surface of very light color.

The decorative treatment in this case is based upon a few simple parts in bold relief, to give a pleasing appearance due to the light and shadow effect. With this is combined a uniform color and even texture of the surfaces. In another track-elevation bridge in Chicago with somewhat similar concrete masking, the surface is mainly flat and is relieved by panels outlined with inserts of colored tile; but the results were not very satisfactory. We pointed out at the time (ENGINEERING NEWS, Sept. 5, 1912) that better results might be expected by relieving the flat surfaces by outline and shadow rather than by the use of color, and this view is supported by the appearance of the bridge described above.

STREET BRIDGES—The same track-elevation work of the Baltimore & Ohio R.R. crosses a number of streets, and the bridges are masked with concrete in the way described above, but with less elaborate design. The girders represent heavy concrete girders with recessed panels on the faces, and a heavy coping. The columns are not incased. These bridges have three bents of five columns each, with transverse plate-girders between the columns, carrying longitudinal I-beams which support the concrete slab deck.

Spheroidal Gas-Holder Tanks

BY PAUL SEUROT*

[Author's Note—This article refers to an illustrated note "Spheroidal-Tank Gas-Holders, a Modern German Type," published in ENGINEERING NEWS, of June 25, 1914, p. 1418. The remarks on design given by the author are based on notes compiled some years ago from the reports of "La Société Technique du Gaz en France." 7e Congrès, Juin 1910.]

The usual formula giving the thickness e of the plating in a gas-holder tank is:

$$e = \frac{HD}{2KS}$$

in which H is the height of the tank, D its diameter, K the ratio of the strength of a riveted section to the strength of the solid section, S the unit-stress.

The intention of the designers of the spheroidal tank, the Maschinenfabrik Augsburg-Nürnberg, is to replace the straight vertical wall of the tank, subject to unequal stresses and necessarily very thick, by a curved and flexible wall stressed equally at all points. This curve follows exactly the natural curvature of a drop of water or of a thin rubber-silk bag filled with water, suspended by a string and resting on a flat unyielding base (see Fig. 1 and Fig. 2); this bag and its contents then take such a shape or position of equilibrium that there is no shear in the shell at any point, the stress being purely tensile.

As pointed out in the article in ENGINEERING NEWS, above referred to, the tank cannot be a closed figure and the meridian tension must be counteracted by vertical struts. This is shown in Fig. 3. The

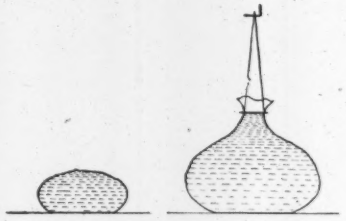

FIG. 1 FIG. 2 FIG. 3

resultant force at A is tangential and acts along line AF. This force is resisted by a circular horizontal built beam AA', and by the vertical struts DAB, which are connected together by X-braces.

The vertical struts are carried on foundation blocks K through the tank plating. The cylindrical volume of water within surface IC is supported directly by the bottom plating and foundation. The volume comprised between IC and the shell produces a downward pressure which is carried through K onto the foundations.

To draw the curve of the shell, let us assume the problem solved and let AB, Fig. 5, represent the curve which is supposed to resist equal tensile stresses at all points. Let us take a slice one meter wide on the circumference of the opening, and let us divide the curve into a certain number of equal parts; in the present example, there are 15 divisions, 1.10m. long each. At the center of gravity of each of these divisions, and normally, let us draw the water pressure, calculated for each point by multiplying the area of the section, its width by its length, by the

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height of its center of gravity below the top surface. Drawing these forces one after the other, parallel to their direction and proportionately to their value, we get a polygon of forces, Fig. 4, whose closing line RR' is parallel to, and (measured by scale) equal to, the resultant OR' of the several pressures. The lines RO and $R'O$ parallel to the two reactions at the end of the curve give the value of the tensile stresses on the base-plating and at point A.

If we join the intersection of these reactions, in Fig. 4, to the several points of the polygon, we obtain the value and direction of the resultants of all the tensile stresses at each point in the shell. All these resultants must be equal, since the curve is supposed to be such that all the tensile stresses are alike. Therefore, *these lines must be the radii of a circle whose center is the intersection of the reactions,* and passing through the several points of the polygon. In other words, we should be able to inscribe the force polygon within this circle.

If now we draw the equilibrium polygon by laying, at each point of the curve, lines parallel to the rays of the force diagram, the sides of the equilibrium polygon will be tangent to the curve of the shell, and if we started at the lowest point the last side should pass at the top through point A.

In practice, the lower and higher points being given, it is customary to draw a trial curve, applying the hydrostatic pressures at each division. The force diagram corresponding to these pressures being drawn, it should be possible to inscribe it in a circumference if the original curve was correct. A few trials may be necessary to obtain the proper curve.

The weight of a tank designed along these lines will be about two-thirds of the weight of a vertical-side tank for the same unit-stress.

For instance, for a tank 13m. high and 65m. in diameter, with a unit-stress of 10 kg. per sq.mm., the thickness of the lower plating should be, in a cylindrical tank,

$$e = \frac{65 \times 13}{2 \times 10} = 42\ mm.$$

The thickness at the top would be from 6 to 7 mm. In a spheroidal tank, the thickness e would be constant and equal to:

$$e = \frac{62{,}100\ kg.}{950 \times 10} = 6.5\ mm.$$

In practice, a uniform thickness of 8 mm. would probably be adopted.

The above conditions obtain when the tank is full. When the tank is being filled, the tensile stresses induced in the wall are not equal. In order to avoid any deformation of the shell during the filling operation, the shell is connected to the vertical uprights by means of latticed girders (Fig. 6). The rivets connecting the latter to the shell cease to be under any stress when the tank is full, at which time the latticed girders could be left out altogether.

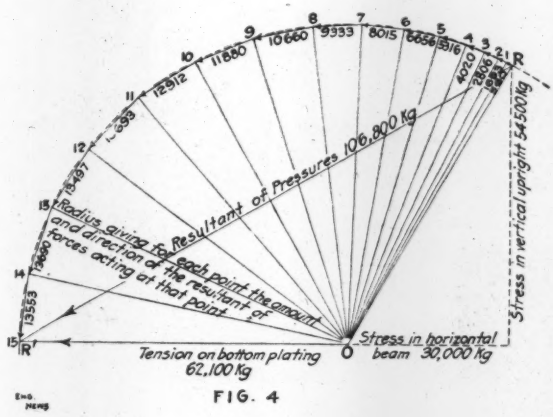
Radius giving for each point the amount and direction of the resultant of forces acting at that point
Resultant of Pressures 106,800 Kg
Stress in vertical upright 54500 Kg
Stress in horizontal beam 30,000 Kg
Tension on bottom plating 62,100 Kg

FIG. 4

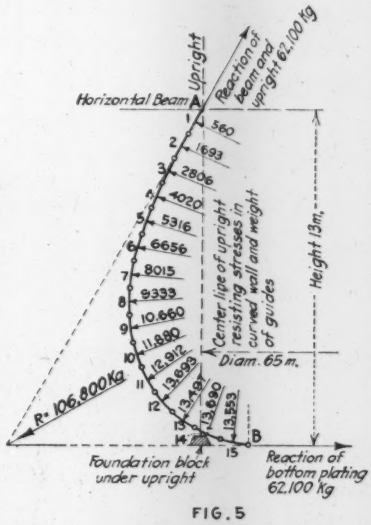
Horizontal Beam
Upright
Reaction of beam and upright 62,100 Kg
Center line of upright resisting stresses in curved wall and weight of guides
Height 13m.
Diam. 65 m.
R = 106,800 Kg
Foundation block under upright
Reaction of bottom plating 62,100 Kg

FIG. 5

FIG. 6

In the case taken here as an example, the water pressures have been determined as follows:

No. of points	Development of skin, m.	Length of skin, m.	Area, sq.m.	Head, m.	Pressure, kg.
1	1.020	1.100	1.122	0.500	560
2	1.040	do	1.144	1.480	1,693
3	1.050	do	1.155	2.430	2,806
..	.....	.....	.....	.....	.....
..	.....	.....	.....	.....	.....
14	0.980	do	1.078	12.700	13,690
15	0.950	do	1.045	12.970	13,553

The Cable Lift Drawbridge of the Pennsylvania Lines over the south branch of the Chicago River is now nearly completed. It is a double-track bridge crossing the river on a skew of about 45° and having a through-truss lift span 272 ft. 10 in. long. The span weighs about 1500 tons, including machinery, etc., and this weight is carried by 64 steel cables 2¼ in. in diameter. There are 16 cables at each corner, pasing over 15-ft. sheaves at the top of the towers, and the 32 cables at each end are attached to a huge steel and concrete counterweight moving in guides on the rear side of the tower. The two towers are 195 ft. high to the centers of the cable sheaves, and are 53½x29½ ft. in plan. The towers were erected first, and then the span was erected in its upper portion on the cantilever system, with a fan-shaped falsework tower at each end, as in the Calumet River bridge for the same railway, described in our issue of Sept. 11, 1913.

When this bridge is completed, the old swing span adjacent to it will be removed, and a second lift bridge erected alongside the first one, thus giving the railway a four-track line into the city. The bridge was designed by Waddell & Harrington, of Kansas City, Mo., and built by the Pennsylvania Steel Co., of Steelton, Pa. The design and construction were under the direction of J. C. Bland, Engineer of Bridges, Pennsylvania Lines.

The Concrete Mixing Plant for Elephant Butte Dam

By L. J. Charles*

General Features—The concrete mixing plant for the construction work of the Elephant Butte Dam on the Rio Grande Project of the Reclamation Service in New Mexico, is of interest, in addition to its size, because of the mechanical means developed to proportion the materials and with a minimum amount of labor.

This machinery is designed for this particular plant, of course, and would not be applicable where the output was to be small or the mixer setting temporary. The conditions here, however, where the output will reach 500,000 cu.yd. or more from one mixer setting justified careful study of the design, in order to eliminate as much hand labor as possible, and this same point has been kept in mind also in the power house, sand-cement plant and other places.

Fig. 2 shows in plan the general arrangements with respect to cableways, railroad, sand-cement plant, etc. Fig. 3 shows the mixing plant and elevating facilities from the crushers. The position of the mixing plant in respect to the dam may be gathered by noting the axis of the dam in Fig. 2.

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The mixing-plant foundation is at Elev. 43[illegible] and the crest of the dam will be at Elev. 4414. The [illegible]" cableway is about over the center of the proposed roadway on top of the completed dam, which will strike the natural surface close to the sand hopper shown. The mixing plant, etc., are upstream from the dam.

In the mixing plant the three 80-ft. mixers are handled by two laborers and a plant foreman in general charge. This force can work the plant to capacity with a uniformly good output, the proportions of which are definitely known and which can be varied only by deliberate settings of the measures. The number of batches from each machine is automatically registered on tallying machines, and the combination of the number of batches and the known cubic contents of the measures gives all the data required for accurate determination of the quality of materials used for cost-keeping purposes.

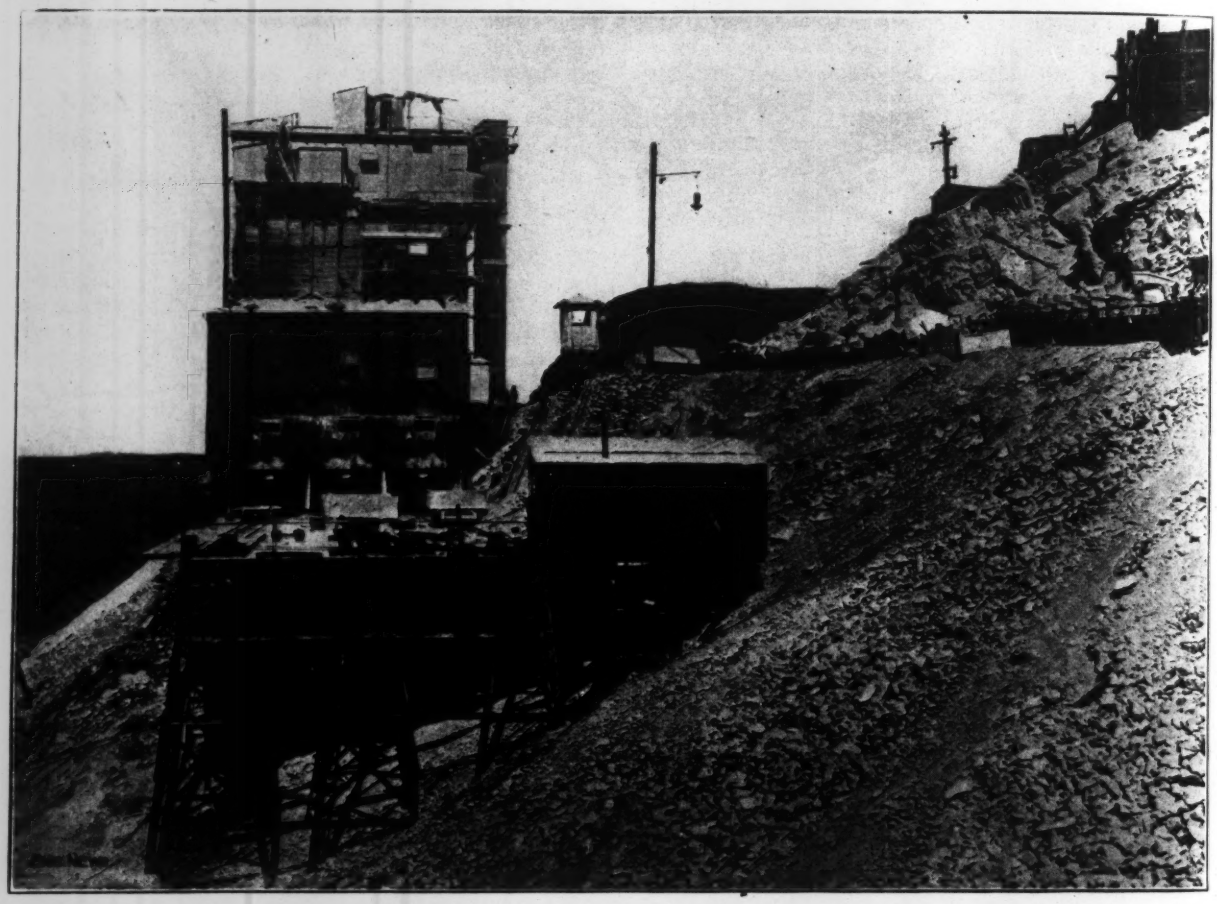


Fig. 1. The Concrete Mixing Plant at Elephant Butte Dam

The laborer's duties consist of throwing a four-way cock through 90° to charge the mixer, and back through 90° to dump the batch and refill the measures. The plant foreman sees that materials are properly distributed, that concrete is delivered to the proper cableways, and looks after the operation of the plant in general.

Plant Details—Fig. 4 gives a general idea of the mixing-plant construction. The building is 24x40 ft. in plan, 74 ft. high, and arranged in five stories, the fifth

of which contains the screening machinery and head shafts of the various elevators.

The fourth story, comprising the bins, is 25 ft. high between floors, and is divided, the 40-ft. way, by two partitions, making three compartments. The back compartment is 11½ ft. wide, with a capacity of 420 cu.yd. of rock over ½-in. diameter; the center, 7 ft. wide, holds 256 cu.yd. of sand ½-in. and smaller; and the front, 4 ft. wide, holds 103 cu.yd. of cement. The sand and rock bins are flat-bottomed. The cement bins are hopper bottomed, metal-lined, and deliver through 12x12-in. metal chutes through the vertical wall of the sand bin, and by a 45° elbow through the sand-bin floor to the cement measures.

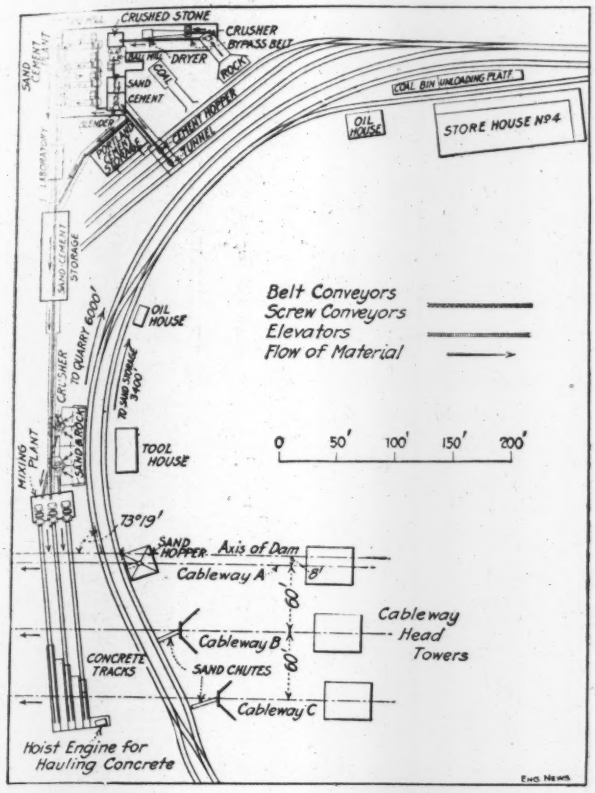


FIG. 2. PLAN OF ELEPHANT BUTTE MIXING, SAND-CEMENT AND STORAGE PLANTS

The third floor of the building is the operating floor, containing the controlling devices for the gates, the measuring devices, which are suspended from the ceiling, the mixer-motor controllers, and the batch-tallying devices.

The second-floor houses, the three 80-cu.ft. mixers, which are arranged side by side, and dump into hoppers over the cement tracks on the ground floor. The cement tracks run approximately at right angles to the three cableways (which parallel the axis of the dam), and extend under each cableway so that material from any mixer may be delivered to any cableway independently.

Each mixer in the plant is an independent unit, having its own measuring hoppers, arranged in tandem for water, cement, sand and rock, and its individual cement bin, but draws rock and sand from a common bin through its own chutes. The mixing units are numbered from the main railroad track outward (see Fig. 2). Nos. 1 and 2 are arranged for 1:9 mix, and No. 3 for 1:6 mix. The proportions are determined by volumes.

The maximum practicable charge for one batch to an 80-cu.ft. mixer has been found to be 75 cu.ft. of loose, dry material, but for various reasons this has been reduced to a little over 66 cu.ft. The proportions for the 1:9 mix (adjusted by Fuller's method) are 1:2.9:6.1, requiring 7.5 cu.ft. of sand cement, 18.87 cu.ft. of sand, and 39.8 cu.ft. of rock. Weight of the batch is approximately 6600 lb.

The 1:6 mix is proportional as 1:1.8:4.2, and a batch consists of 10.7 cu.ft. of sand cement, 16.75 cu.ft. of sand, and 39.1 cu.ft. of rock. Both batches give a resultant of about 1.63 cu.yd. of mixed concrete. These proportions are adjusted from time to time as the material varies.

It is not planned to operate more than two mixing units at one time, but since each batch weighs over three tons, and each mixer can turn out 30 batches an hour easily, at least 180 tons of material must be handled per hour, and accurately measured as used.

Figs. 5 and 6 show the details of the sand and rock measures used on all three units. Measures similar to these have been used for sand and rock on the Pathfinder dam in Wyoming, and the Strawberry Valley project in Utah—although in both cases they were much smaller and were manually operated. These measures for the 1:9 mix can be adjusted by the telescoping attachment in the case of the rock between limits of 41.08 and 53.05 cu.ft. and in the case of the sand between 18.33 and 23.68 cu.ft. The No. 3 sand hopper is reduced by an internal bushing, and its capacity can be varied between 16.18 and 21.53 cu.ft.

Fig. 7 shows the design for the cement measures as originally installed. The knife edges of the segmental gates, upon which their tightness depends, were quickly ruined by catching fragments of hard material (broken pebbles, etc.) between the gate and the chute. Cement under the 28-ft. head acts in some respects like water, but has all the bad arching tendencies of sand when the flow is once arrested. Under the head mentioned a leak of knife-edge or pin-hole size will quickly waste a large

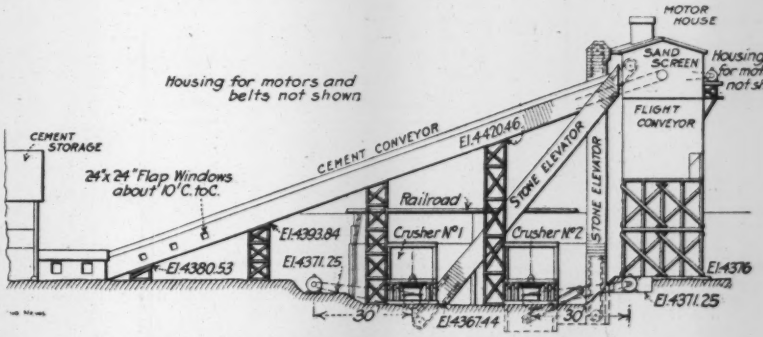


FIG. 3. GENERAL ELEVATION OF MIXING, CRUSHING AND ELEVATING PLANTS

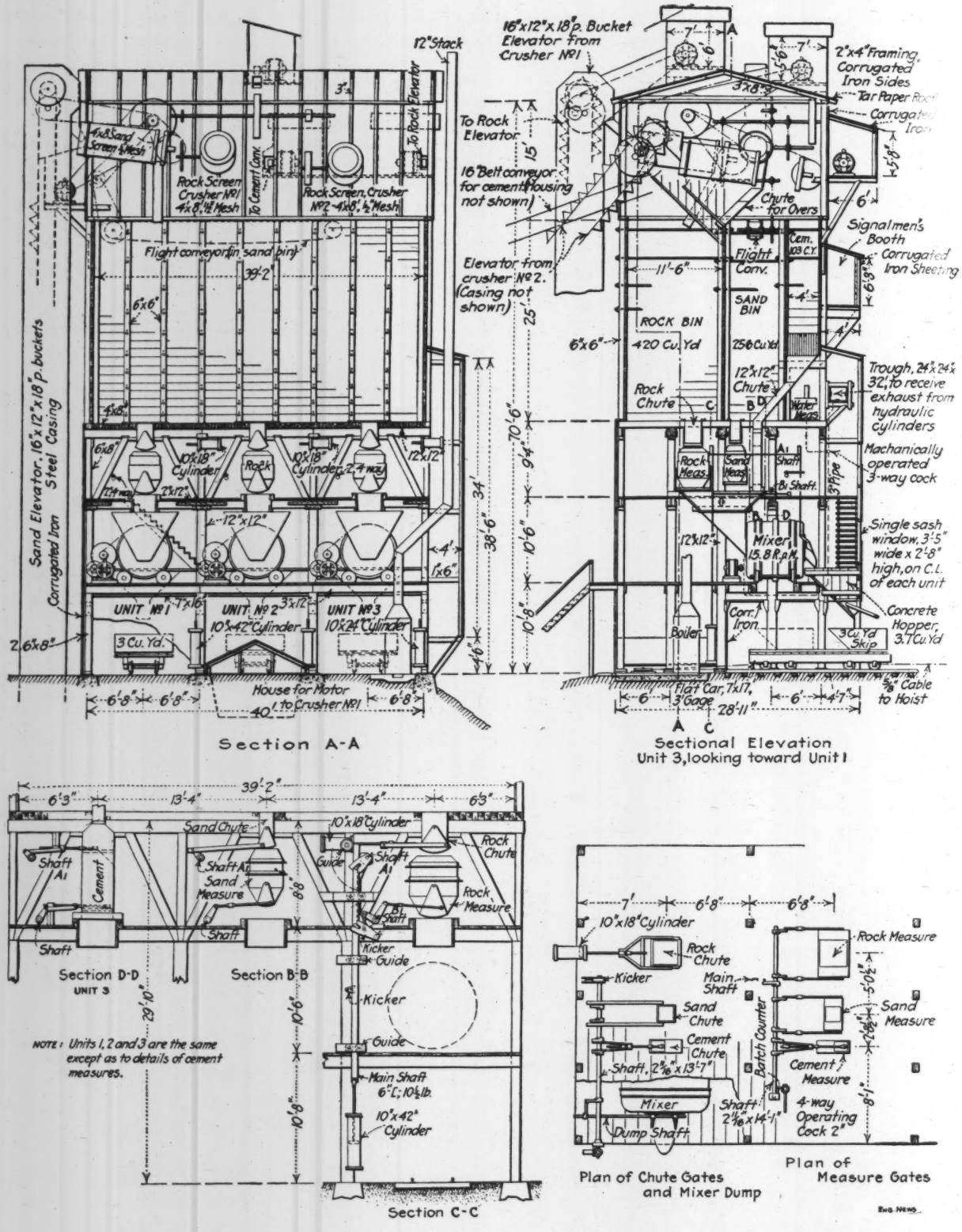

Section A-A
Sectional Elevation
Unit 3, looking toward Unit 1
Section D-D
UNIT 3
Section B-B
Section C-C
NOTE: Units 1, 2 and 3 are the same except as to details of cement measures.
Plan of Chute Gates and Mixer Dump
Plan of Measure Gates
Eng. News

FIG. 4. ARRANGEMENT OF MACHINERY IN MIXING PLANT; ELEPHANT BUTTE DAM

amount of material. The arching action has been overcome by introducing a jet of compressed air at the junction of the bin with the 12x12-in. chute (see Fig. 4). The introduction of air is controlled by a whistle valve, which is opened for an instant by the operator if an arch has formed.

Attempts were made to improve the segmental gates by hinging them eccentrically, and by replacing them with slide gates operating through the sides of the measures. It was found impracticable to pack the slide-gate slots so that they did not leak externally, without lifting them from their seats and causing internal leaks.

The original measures were finally discarded; Figs. 8 and 9 show the design of those now in use. The gates are slide gates operating over ports in the gate seats and sliding entirely within the measure. The inclined gate in Fig. 8 has been milled out ¼ in. deep, except for an inch lap around the seat, so that the gate becomes self-cleaning, and the gate guides have been removed as unnecessary. Before the gate was milled it showed a tendency to ride over the cement left on the seat, gradually developing leaks. Ample armholes have been introduced to aid in removing pebbles, etc., which are caught at the acute angle. The 2x4-in. openings covered by loose canvas diaphragms, are indicators to show when the measures are full. The 1¼-in. pipe is a vent for the relief of air compressed in the measures by the falling cement.

In the design of the operating mechanism there was the choice of water, compressed air, and electricity as motive power. Water was decided upon as the easiest controlled, slowest and steadiest in operation, while the exhaust could be used in the mix, thus getting work out of the water that would otherwise be wasted.

No data could be found upon which to base the cylinder sizes for the installation, and the following assumptions were made in the design: efficiency of the apparatus, 30%; power required to move a segmental gate, equal to the coefficient of friction of rock on steel times the weight of a column of rock 27 ft. high, and of a cross-sectional area equal to that of the opening to be cut off. The wedging of rock in the gate was allowed for by clearance of the gate below the chute. As the worst case would be that of the rock-chute gate, which if blocked would lock the entire mechanism, this was designed with a separate cylinder of its own, 10 in. in diameter, and 18-in. stroke. All the other chute and mixer gates, also the measured water dump and mixer dump, are operated by one cylinder of 42-in. stroke, 10 in. diameter. Separate cylinders for each set of gates were considered at one time, but the lack of data upon which to proportion their sizes and the difficulties of interlocking their movements led to the two-cylinder plan.

In the design of future plants, it would be advisable to make the diameter of the auxiliary cylinder larger than that of the main cylinder, as it is necessary that the rock-chute gate be closed before the main cylinder begins to open the measure gates to avoid bypassing. This difficulty occurs with this plant at times, but is obviated by throttling the flow of water to the main cylinder, so that the main piston rod moves slower than the auxiliary one. An increase in the size of the rock-chute cylinder, however, would be more logical and a better solution.

The static head of water available for power varies between 128 and 151 ft., according to the level of the water in the main-plant supply tank from which it is drawn. With heads greater than these, provision for the relief of water-hammer should be made.

Fig. 4 shows the operating-mechanism layout as in-

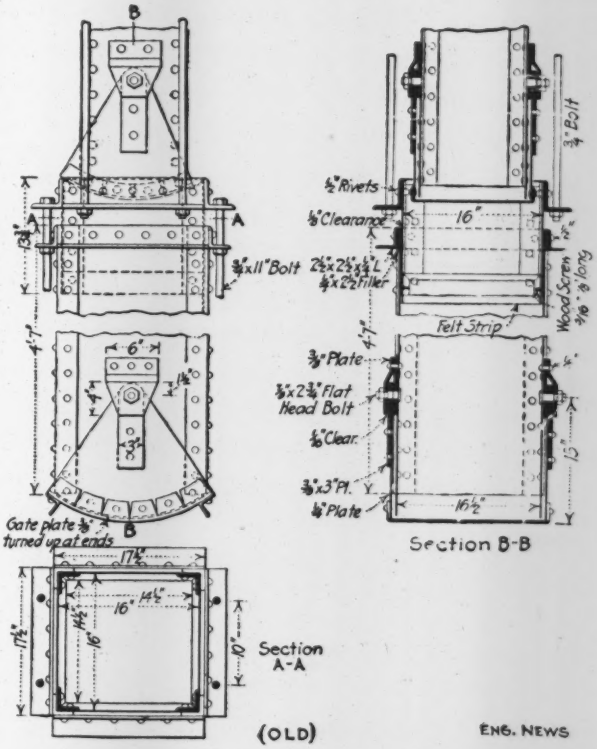
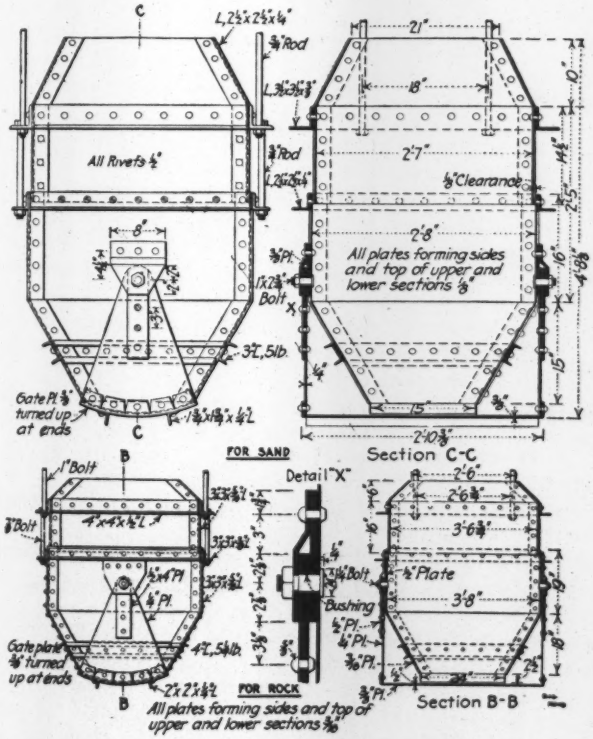
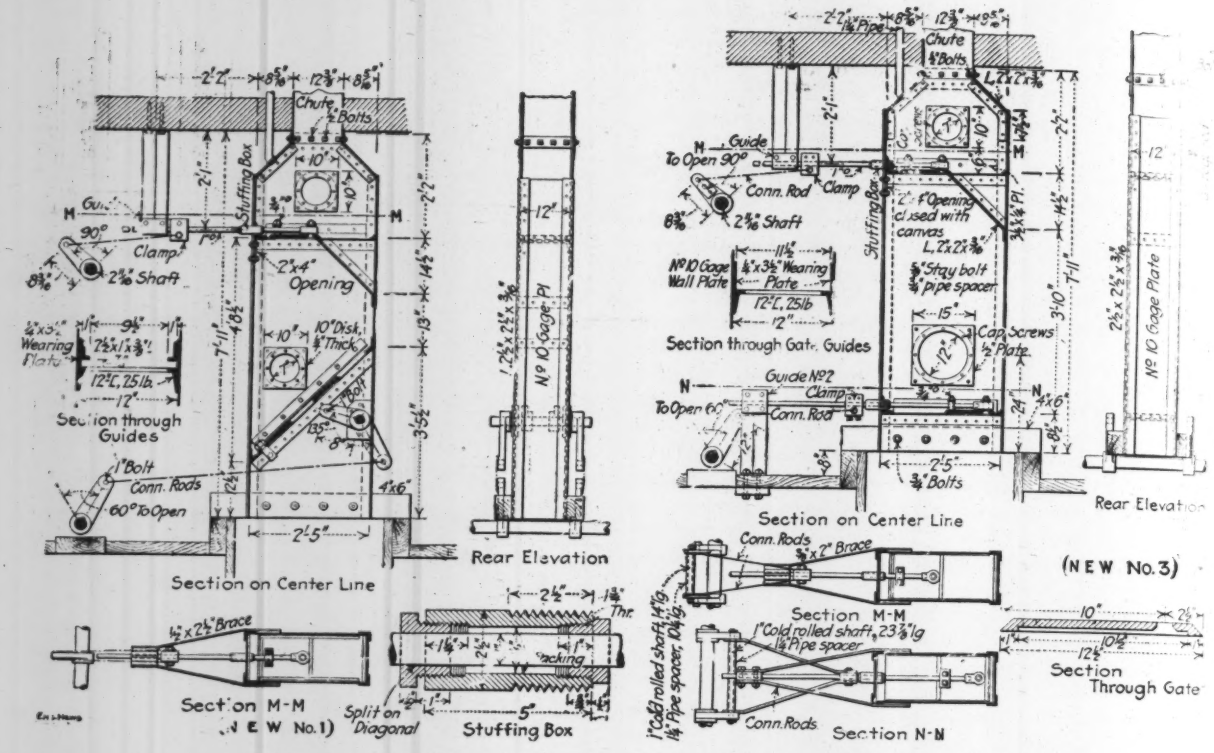


FIG. 7. OLD CEMENT MEASURE



FIGS. 5 AND 6. ROCK AND SAND MEASURES



FIGS. 8 AND 9. NEW CEMENT MEASURES, ELEPHANT BUTTE PLANT

stalled. The piston rod of the 42-in. cylinder is extended through two floors by means of a channel extension which carries lugs to engage "kickers" on the various shafts to be operated, which are in turn connected to the various gates by crank arms and connecting-rods.

The "kickers" are built up of plates slotted out to engage the lugs on the plunger. Each kicker has an angle-iron wing upon which the plunger lug slides after the movement of the kicker is complete, thus introducing a time element between the closing of one set of gates and the opening of another.

Fig. 4 shows the mechanism at the mid-stroke point of the piston, with the A_1 kicker ready to engage on the up-stroke, and the B kicker half rotated. The B kicker operates all the measure gates; the A_1 all chute gates, the mixer dump, and the water measure three-way valve. The operation of the rock-chute gate cylinder is controlled by the G kicker, which rotates a three-way valve.

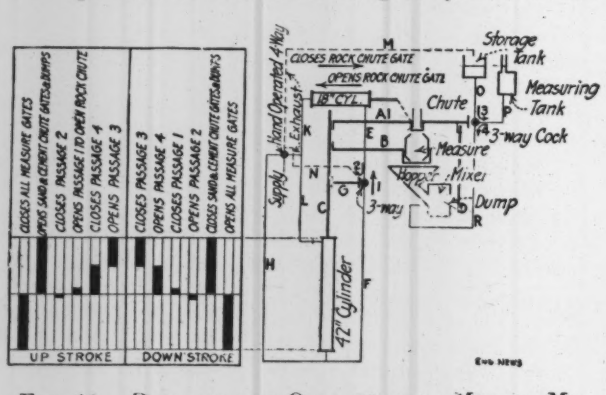


FIG. 10. DIAGRAM FOR OPERATION OF MIXING MACHINERY

Fig. 10 shows diagrammatically the operation of the mechanism. Starting with the piston of the 42-in. cylinder at rest at the bottom of its stroke, and a charge in the mixer being mixed, the measure gates are open and the measures empty. The operator throws the handle of the four-way valve 90°, admitting water from the main supply through the pipe H to the bottom of the 42-in. cylinder, and through F as far as the three-way valve, which is closed. The plunger C begins to rise, the cylinder exhausting through L, the four-way valve and M to the storage tank. A plunger pin on C starts rotating the B shaft by means of its kicker, and closes the measure gates. This closure is completed just before the half stroke, and a second pin engages the G kicker, closes Passage 2, through which the forward end of the 18-in. cylinder exhausted during the cycle previous, and opens Passage 1, allowing water from the main supply to pass through E to the forward end of the 18-in. cylinder. This rotation of G is completed just over the half stroke, when a third pin engages the A_1 kicker and starts opening the sand and cement-chute gates as the small cylinder opens the rock-chute gate. The small cylinder on this stroke exhausts through K the four-way and M to the storage tank.

The A_1 shaft as it rotates dumps the mixer and rotates the three-way valve, closes Passage 4, through which the measuring tank had delivered its measured charge of water to the mixer through pipes P and R. The closure of this passage is completed on the three-quarters point of the upstroke, and the opening of Passage 3 begins, which admits water from the storage tank to fill the measuring tank through pipes O and P. The time required to dump the mixer is the longest period in the cycle, and

depends, of course, on the consistency of the batch. The water levels in both tanks equalize. The details of the adjustment device in the measuring tank, and also the piping layout, are shown by Fig. 11.

Referring again to Fig. 10, the upward travel of the plunger *C* having been completed, the piston of the 42-in. cylinder comes to rest against the cylinder head. The mixer is dumped, and the measures are all filling. As soon as this is completed, which takes only an instant, the operator throws the four-way back 90° to its original position. This admits water through *L* to the large cylinder, which exhausts through *H* and *M* to the storage, and through *K* to the short cylinder, which exhausts through *E, F, H* and *M* to the storage.

The falling plunger *C* begins to revolve the A_1 shaft, whose kicker is engaged closing the sand and cement-chute gates, also the mixer dump, and the piston of the 18-in. cylinder moves to the right to close the rock-chute gates. The rotation of A_1 closes Passage 3, which is completed on the half stroke, dumping the water charge to the mixer. Just before the half stroke *G* is engaged, closing Passage 1, opening Passage 2, and changing the path of the exhaust of the 18-in. cylinder from *E, F, H*, four-way, *M*, to *E, N, M*, direct to the storage tank. (This is done to close Passage 1 which controls the opening of the rock-chute gate on the upstroke.) The closure of the chute gates and mixer dump by the revolution of A_1 is completed on the half stroke down, and kicker *B* is engaged opening the measure gates and dumping the contents of the measures into the mixer, which operation is completed by the time the piston strikes the lower head of the cylinder.

It will be noted that the water charge starts to the mixer on the quarter stroke down, when the mixer dump is only half closed, but the slow opening of Passage 4 retards the flow, and no water reaches the mixer until the dump is well raised. The water is in the mixer about three revolutions of the mixer before the aggregate arrives, forming a cushion for the impact of the 3-ton charge, and saves wear and breakage of the mixer vanes. It also washes the mixer, removes the cement left by the previous charge, and prevents any gumming up of the mixer with partially moistened cement. The mechanism can be stopped at any point of the stroke, and locked there, by turning the four-way valve to the neutral point. The exhaust water all goes to the storage tank, and finally into the concrete. The storage is fitted with a float-valve supply and overflow, but as a general thing these do not come into use.

The plant was completed and concreting started on the dam in June, 1913, and has continued without delay. One cableway only has been available, and one mixing unit has been operated at about two-thirds capacity. On account of the excavation for foundations being carried on for a new section of the dam while concreting of the present block is in progress and because of the incomplete development of the quarries, it will be several months before the full capacity of the mixing plant can be realized. Judging from the work already done the output and efficiency of the plant will be fully up to expectations.

Personnel

Under the writer's supervision the preliminary plans, and many of the details of the operating machinery were prepared by Assistant Engineer Chas. A. Bissell, while Assistant Engineer Julian Hinds completed the detailing, and designed all the changes mentioned. The machine work and installation was done by Government forces, under W. C. Beatty, Master Mechanic. The Elephant Butte Dam is being constructed under the general supervision of L. C. Hill, Consulting Engineer, with E. H. Baldwin, Construction Engineer, in direct charge.

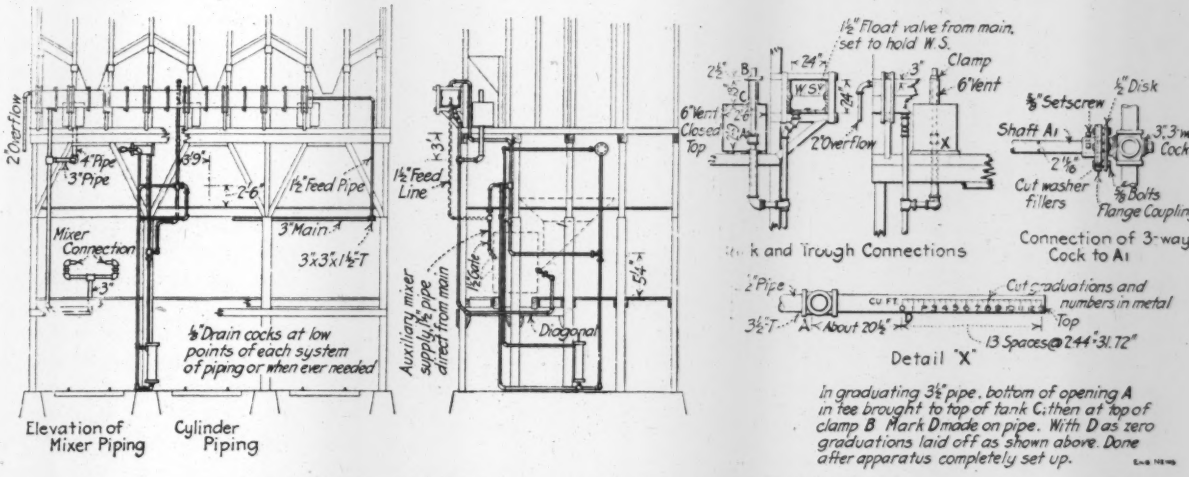


Fig. 11. Piping Arrangement, Elephant Butte Mixing Plant

Some Lessons from the Flood Failures of California Highway Bridges—The lesson taught by the failure of several long span steel bridges during the recent floods in some parts of California was a very valuable one to the counties. Many of the bridge failures were due to faulty pile foundations and consequent settling of piers; others were due to improperly designed abutments; but the principal and most important lesson taught was the urgent necessity for proper protection of the river banks to prevent continued erosion. On every river in Division No. 5 the erosion of the banks from the 1914 floods is the one big problem, and this problem should be solved before the acceptance of bridges menaced by this danger; for it may easily happen that a 700-ft. bridge accepted today may be an isolated structure tomorrow, and the expense of all the additional spans necessary to bridge this gap made by the flood waters would have to be borne by the state. [Walter C. Homer, Division Engineer, California Highway Commission, in the July "California Highway Bulletin."]

Lining Long and Deeply Overlaid Tunnels

By Eugene Lauchli*

Only a few years ago, it was generally admitted that the form and thickness to give to tunnel linings was a mere matter of judgment; they were therefore proportioned according to the judgment of the engineer or designer, thus resulting very often in a waste of material, or in partial failures. The numerous observations made in tunnels, mines, shafts, bins, silos, together with laboratory experiments on the behavior of materials under compression, bending, etc., have resulted in throwing much light on this complex subject, and have shown that the designing of the lining of deeply overlaid tunnels, or or any tunnel, should be carefully considered.

Ground Pressure

It has been observed that in moderately overlaid tunnels, signs of pressure or deformation occurred first in the roof; in deeply overlaid tunnels in the sidewalls first, and then in the roof and floor. However, such phenomena have sometimes occurred in a reversed order, due to the peculiar stratification or formation of the ground, and also the crushing strength of the materials under consideration. In relatively soft materials, deformation would appear under the form of crushing or bending of the tunnel roof, floor or sidewalls, while in hard and brittle materials flaking or shelling of the rock would take place.

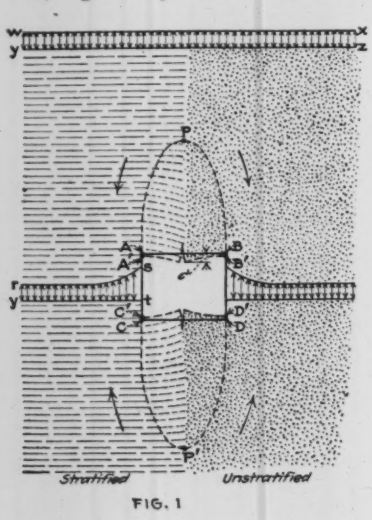


FIG. 1

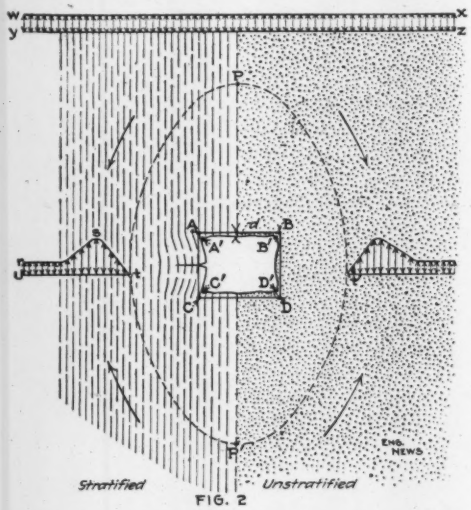


FIG. 2

Figs. 1 and 2. Diagrams Showing Pressure of Overlay in Deep Tunnels

(Fig. 1. In hard, unyielding material. Fig. 2. In yielding material.)

It has also been observed that when a cave-in occurred in an earth or rock tunnel, or when a sand or rock bin, or a silo filled with grain would be emptied from the bottom, the void, resulting from the cave-in, or from the material extracted, would take a vaulted shape, nearing that of a parabola. The height of the vaulted space was found independent of the depth or weight of the overlying materials, but, on the other hand, was dependent on the width of the excavation and of the cohesion of the material under consideration.

The intensity and distribution of the ground pressure may be analyzed as follows: Let *ABCD* (Fig. 1) represent the section of a deeply overlaid tunnel, and let *wxyz* be the weight of the overlying mass, acting say at roof elevation of the bore. The material penetrated is assumed to be hard and solid, stratified horizontally to the left and unstratified to the right. It is evident that the load acting on the roof of the tunnel has to be transmitted to the floor, through the sidewalls *AC* and *BD*. If these are strong enough to resist the additional load, or reaction of the roof load, the stress thus borne can be illustrated by the diagram *stru*, the stress reaching its maximum value at the sidewalls, and decreasing in intensity at a distance away from same, down to a point where *ru* has a value equal to *wy*.

Under repeated blasting, and if the strength of the material penetrated is such as to allow a vertical movement of the roof and floor, the roof line *AB* will move down to *A'B'*, and as action and reaction are equal, the same process will be undergone by the floor line *CD*, to a less extent, however, as the pressure is somewhat counteracted by the weight of the material underlying the floor. A vertical movement having taken place, it is obvious that voids have been created between adjacent imaginary layers of rock above or below the roof and floor lines, and unless due provision is made to prevent further movement of the strata, the bore is liable to fill up, in the course of years, if not immediately. If, on the other hand, adequate timbering or lining is provided, further movements of the ground will be checked, and equilibrium will take place as the voids caused by the initial movement will fill up, due to successive settlements or swelling of the overlying material.

Under normal conditions, the disturbed zone will be confined within an area limited by a parabola, and the load carried by the roof of the tunnel will be that due to the weight of the materials confined within *A'PB'*.

Now let *ABCD* (Fig. 2) represent the section of a tunnel driven through yielding material, stratified vertically to the left, and unstratified to the right. On account of the low crushing strength of the rock penetrated, and the instability of the sidewalls *AC* and *BD* to transmit to the floor the reaction of the roof load, vertical movements of the roof and floor, and horizontal movements of the sidewalls are bound to take place. The zone of disturbance will thus be spread over a large area surrounding the tunnel, and the stresses in the sidewall *AC* for instance, can be illustrated by the diagram *tsru*. It is evident that the long axis of the parabolas *rPt'P'* can assume different po-

*Civil and Hydraulic Engineer, New York.

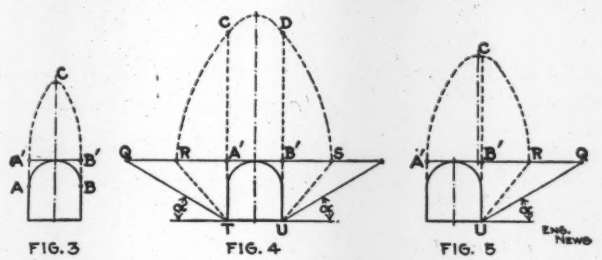
sitions, according to the inclination of the strata; but whatever position the axis may assume, the load to be carried by the tunnel lining, in deeply overlaid tunnels will always be a small fraction of the overlying depth.

The load acting on the roof and floor of a tunnel driven through hard and solid material will therefore be limited by the line $A'PB'$ and $C'P'D'$ (Fig. 1). The location of P' above the tunnel roof will depend on the width of the bore as well as on the cohesion of the overlying material.

The load acting on the roof, floor and sidewalls of a tunnel driven through yielding materials will be limited by the line $tPt'P'$ (Fig. 2); the ground beyond these lines is supposed to have no action on the tunnel lining or timbering, provided unusual conditions such as geological faults, action of air or water on the rock, etc., will not cause large masses of ground to be set in motion, thereby causing unsymmetrical or excessive pressure.

According to the geological formation and stratification of a site considered, the following cases of loading are encountered most usually in deeply overlaid tunnels.

Case I (Fig. 3). The pressure acts vertically; there is no sign of pressure on the sidewalls. The lining should therefore be designed to carry the weight of the parabola



FIGS. 3 TO 5. TYPES OF PRESSURE CONDITIONS ABOVE DEEP TUNNELS

ACB; for all practical purposes the points A and B are assumed to be in $A'$and B', located at crown arch elevation.

Case II (Fig. 4). The pressure acts vertically on the arch; signs of weakness are noticeable in the sidewalls. The arch is to be designed to carry the weight $A'CDB'$. If α represents the angle of repose of the material, it can be assumed for all practical purposes that the intersection of the line of rupture TK, with a horizontal line passing through the crown of the tunnel arch, is located at a point half-way between QA', or at R. Therefore, the sidewall $A'T$ is to resist the pressure due to the weight of the triangle $RA'T$, carrying the additional load RCA'.

Case III. (Fig. 5). The pressure is unsymmetrical to the center line of the tunnel, such a condition being caused either by the inclination of the strata or the yielding of the materials on the right-hand side of the tunnel. In this case, the arch should be designed to resist the stresses caused by the weight of $A'CB$; and the sidewalls are to resist the pressure caused by the weight of $B'RU$, supporting the additional load $B'CR$.

FORMULAS FOR GROUND PRESSURE—Several formulas that serve the purpose of determining the height of the parabola that represents the overlying weight acting on tunnel linings have been devised, but as it is beyond the scope of this paper to present and discuss all of these, the Kommerell formula only, together with a table giving results for different kinds and conditions of materials is given here. The Kommerell formula is based on the deflection of the roof of a bore, or tunnel, and, as for the same kind of material, the deflection due to bending, increases with the width of the bore, the height of the parabola becomes a function of the tunnel width and of the kind and cohesion of the overlying material.

TABLE I. COEFFICIENTS IN FORMULA $H = \frac{100\,d}{C}$

Material	C
Pine sand, dry	1
Sand, gravel	1.5
Earth, loam, etc.	2 to 4
Marl	4 to 5
Shale	6 to 7
Harder rocks	8 to 15

TABLE II. VALUES OF H IN FORMULA $H = \frac{100\,d}{C}$

	Value of C.									
	1	1.5	2	4	5	6	7	8	10	12	15
d.	H	H	H	H	H	H	H	H	H	H	H
0.2	20	13	10	5	4	3.3	2.8	2.5	2	1.6	1.3
0.4	40	23	20	10	8	6.7	5.7	5	4	3.3	2.7
0.6	60	40	30	15	12	10	8.6	7.5	6	5	4
0.8	80	53	40	20	16	13	11	10	8	7	5
1.0	100	67	50	25	20	17	14	12	10	8	7
1.2	120	80	60	30	24	20	17	15	12	10	8
1.4	140	93	70	35	28	23	20	17	14	12	9
1.6	160	107	80	40	32	27	23	20	16	13	11
1.8	180	120	90	45	36	30	26	22	18	15	12
2.0	200	133	100	50	40	33	28	25	20	17	13
2.2	220	146	110	55	44	37	31	27	22	18	15
2.4	240	160	120	60	48	40	34	30	24	20	16
2.6	260	173	130	65	52	43	37	32	26	22	17
2.8	280	186	140	70	56	47	40	35	28	23	19
3.0	300	200	150	75	60	50	43	37	30	25	20

Let d (Figs. 1 and 2) represent the deflection observed in a tunnel roof; let C have the value given in Table I, and H be the height of an ellipse substituted with sufficient accuracy for all practical purposes to the parabola above the tunnel roof; then $H = \frac{100\,d}{C}$, the value of d and H being expressed in feet.

Table II indicates that, in a tunnel driven through sand, and with a roof deflection or settlement of 2 ft., H is equal to about 133 ft. If the material penetrated is shale, H will have an average value of 33 ft. In a deeply overlaid tunnel, C will have usually a value of 6 or more, for in such tunnels, rock only is usually encountered. However, judgment is to be exercised in selecting the proper value for C, as a roof deflection of say, 2 ft., may give H a value of 33 or 13 ft. ft. according to whether the rock penetrated is soft sandstone or limestone, or harder rocks such as granite, gneiss, etc.

TUNNEL SECTION

Having determined approximately the weight acting on a tunnel lining, the next step is to select the type of cross-section best suitable to resist the stresses borne by same. Theoretically, there is but one tunnel section that is most economical, corresponding to a given condition of loading; in actual practice, however, it would be unpractical to change the tunnel section very often; furthermore, certain clearance lines for the rolling stock and for other purposes have to be strictly observed; it is also desirable that the masonry forms and tunnel centers be made as uniform as possible. For the above reasons, it is usually the practice to design a few types of lining sections, the strength of which is determined *a priori*, adapting same, where found necessary, to conditions of loading.

In deep tunnels, and in tunnels subjected to ground pressure, it is desirable to make the roof of the bore as narrow as possible, thus making itself sustainable. In order to minimize the thickness of the arch, the thrust at the crown is reduced, by making the ratio of the arch

span to the rise as small as conditions of clearance will permit. The type of arch answering best the above requirements is that nearing the parabola; but, for reasons of construction, the arch is usually made up of segments of circles. Straight lines are avoided altogether, and provision is made for future insertion of an invert, when deemed advisable.

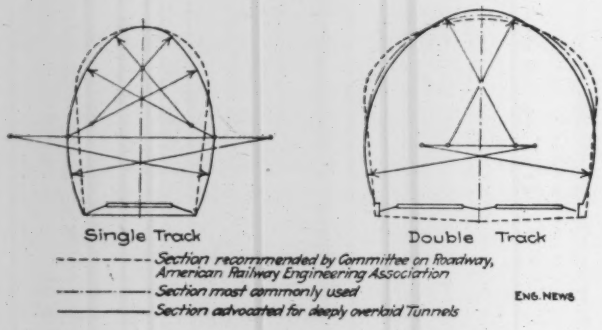

Single Track
Double Track
Section recommended by Committee on Roadway, American Railway Engineering Association
Section most commonly used
Section advocated for deeply overlaid Tunnels
ENG. NEWS

FIG. 6. TUNNEL SECTIONS FOR SINGLE AND DOUBLE TRACK

Fig. 6 shows the section recommended by the Committee on Roadway of the American Railway Engineering Association for single-track and double-track tunnels, together with that section mostly used and that section advocated by the writer for deeply overlaid tunnels. The area of the last named section is somewhat larger than the section recommended by the committee.

LINING MATERIALS

Opinions as to the kind and quality of materials best suitable to line deep tunnels, all aim toward the same results, i.e., toward material that will reach its maximum ultimate strength soon after being used, and that possesses a high compressive strength, together with great resistance against action of water, heat, frost and gases from locomotives. The question of strength is obvious, for the thicker the lining, the wider the bore, and the greater the amount of excavation and masonry.

On account of the small compressive strength of brickwork, the use, in recent practice in deep tunnel work, of brick lining has been closely limited. In general, local conditions decide whether rubble or concrete masonry, or artificial masonry blocks are to be used. Rubble masonry, besides having a relatively low compressive strength, possesses the same disadvantages as concrete, i.e., the maximum strength is reached only long after being laid; and in wet sections, or in heavy pressure zones, both of these materials have proved to be rather unsatisfactory. In dry sections, and where the lining answers merely the purpose of preventing falls of rock, concrete may often be found cheaper than stone masonry.

Concrete and artificial masonry blocks are coming more and more into favor, and in general, have given much satisfaction, both during and after construction. Such blocks possess the advantage of being manufactured in advance, and when used have already reached a high compressive strength. They can be placed more rapidly than dressed stone or brick masonry, and as the compressive strength of artificial or concrete blocks is more uniform than stone or brickwork, a smaller factor of safety can be used. Plain concrete blocks have been used in connection with the lining of several tunnels, and generally have given much satisfaction. Concrete blocks having an ultimate strength of 1200 to 2000 lb. per sq.in. were used extensively in lining the first bore of the Simplon tunnel. Similar blocks possessing an ultimate strength of 2500 lb. per sq.in. were used in lining the Loetschberg tunnel. The lining of the 26,683-ft. Hauenstein double-track tunnel and part of the second bore of the Simplon tunnel will consist of artificial masonry blocks possessing, when placed, 70% of a guaranteed ultimate compressive strength of 2844 lb. per sq.in. These same blocks when tested were found to have an ultimate strength of 4000 to 5000 lb. per sq.in.

Concrete blocks of the interlocking type are being used extensively in connection with the lining of the Mount Royal tunnel at Montreal and the method of erecting these blocks will undoubtedly make their use very popular in deep tunnels where a strong lining is often required soon after the excavation has been completed.

A New Portable Asphalt Mixing Plant; Catskill Water Supply Roads

A portable asphalt-mixing plant, shown in the accompanying illustration, Fig. 1, has been in use for the past two months on one of the roads built around the Ashokan reservoir by the Continental Public Works Co. for the Board of Water Supply of the City of New York. The apparatus was made by the F. D. Cummer & Son Co., Cleveland, Ohio, and consists of three units, which may be separated and loaded on flat cars in a few hours. According to W. B. Spencer, President of the Continental Public Works Co., the plant has averaged approximately 1060 sq.yd. of 2-in. bituminous top mixture per day, and has proved efficient and economical.

ASPHALT-MIXING PLANT

FIRST UNIT—The first unit consists of a drum sand dryer, having a rated capacity of 8 tons per hr., but with a tested capacity of 11 tons, with sand carrying 7% moisture and heated to 350° F.; a two-shaft batch mixer of 5 cu.ft. capacity; a sand-bin of 5½ tons capacity, with a rotary screen so arranged that sheet asphalt, asphalt binder, or asphaltic concrete may be mixed without changing the arrangement of the units; a sand measuring box on a beam scale, so arranged that each aggregate may be weighed separately or in combination, and an asphalt bucket on a double-beam scale. This whole unit is mounted on an all-steel truck (Fig. 2) with 30x12-in. front wheels and 36x12-in. rear wheels. Power is transmitted by one main shaft 2 7/8 in. in diameter and one main belt drive from the engine. The drum and mixer are directly connected to the main shaft.

SECOND UNIT—The second unit is the power unit, consisting of a 30-hp. locomotive type of portable boiler with a 25-hp. horizontal engine mounted on top, made by the Erie Engine Works, Erie, Penn.

THIRD UNIT—A 10-ton portable asphalt-melting kettle constitutes a third unit. This unit is also mounted on an all-steel truck with steel wheels. Kettles are also made in 5-ton sizes.

The whole plant is modeled after the larger railway-

FIG. 1. PORTABLE ASPHALT MIXING PLANT; ASHOKAN RESERVOIR ROADS, NEW YORK

FIG. 2. MIXER UNIT, CUMMER PORTABLE ASPHALT MIXING PLANT

car mixing plant, which has been made by the same company for several years. The car plant has a capacity of 2000 sq.yd. of 2-in. bituminous top mixture per day, or about double the capacity of the portable plant.

The portable plant is designed to be hauled along the road as the work progresses. All the construction work that is necessary is to jack up the wheels of the mixer about 2 ft. to permit a wagon to be backed under it to receive the load. In Fig. 1 two standard kettle units are shown, one 10- and one 5-ton, but the trucks have been removed.

METHODS OF CONSTRUCTION; ASHOKAN ROADS

The Board of Water Supply specifications call for a pavement made of a 2-in. bituminous wearing course of 1½-in. stone with a seal coat of asphaltic cement and stone chips (stone passing ½-in. screen and retained on dust jackets), laid on a 6-in. bottom course of rolled crushed stone. The broken stone for the bituminous wearing course is heated to between 225° to 300° F.

The asphalt cement is required to be heated separately from 275° to 350° F. The mixture used contains 5 to 7½% bitumen by weight. The mixture is delivered on the road at a temperature of not less than 150° F. As soon as the wearing course is completed and rolled and the surface is clean and dry, the seal coat of hot asphalt cement is spread with squeegees or other suitable methods, at a temperature of not less than 275° F., or more than 350° F. The rate of application is between ½ and ¾ gal. per sq.yd. On this is immediately spread a uniform layer of dry stone chips, and the pavement is rerolled.

Steel Ties on Swiss Railways represent 65% of the mileage of the government railways. They are of rolled steel, of inverted trough section, with ends bent over and closed, and the ties are bent longitudinally so that the rail seats have an inclination of 1 in 20. The weight of the tie is about 160 lb. The rails are secured by clamps, and no tie-plates are used. At the rail joints, wide double-trough ties under the joint are now being used, instead of two closely spaced shoulder ties; these joint ties weigh about 276 lb. The above information is given in a recent consular report.

Rolling Asphalt Surfaces to Avoid Depressions—An English engineer, C. H. Cooper, Engineer and Surveyor of Wimbledon, has applied for a patent on a method of preventing depressions in rolling asphalt pavements, which he describes in a letter to the "Surveyor" of July 10, as follows:

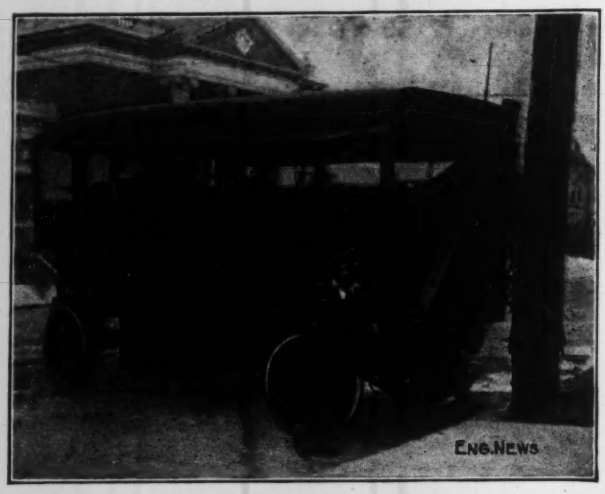
In rolling asphalt it is necessary to bring the roller to a standstill for the purpose of reversing; in so doing the front rolls become stationary on the hottest, and certainly on that portion of the asphalt which can least resist their weight; the consequence is that depressions are formed in the asphalt, which should have a perfectly even surface so as to avoid the corrugations found in most pavements. In order to distribute the weight of the front rolls, and so avoid the formation of depressions, I place a sheet of iron on the asphalt—on this sheet the front rolls rest when the roller is brought to a standstill.

Field and Office

Moving Loaded Electric-Light Poles

By C. E. Drayer*

When a portion of St. Clair Ave., Cleveland, is repaved this year, both curbs will be moved back 2½ ft. between East 23rd St., and East 55th St., so that the width of pavement will be 60 ft. and uniform with that east of East 55th St. The plan to move the curbs required the Cleveland Electric Illuminating Co. to move back a line



Electric Truck in Cleveland Fitted for Moving Poles

of heavy poles a like amount. On the average, the poles are 50 ft. long, and carry four crossarms and about two dozen wires.

From East 23rd to East 40th St., the poles were moved back by hand by jacking them along cross trenches. But between East 40th and East 55th St., a 12-in. gas main, some 4 ft. in the ground, was against the poles on the back. To get the line to its new position, it was necessary to raise the poles vertically some 3 ft.

A 3½-ton electric truck equipped with a 3-hp. motor and winch for pulling cables through underground conduits, was rigged up with derrick and tackle as shown by accompanying figure. Four legs, 6-in. channels with 1-in. holes punched along the center, were made fast to the bed of the truck at one end and bolted together at the top.

In operation, the truck backed up to the pole with the rear wheels as far from the face of the curb as the pole was to be moved back. A chain, to which the tackle was hooked, was wound about the pole near the surface of the ground and a jack placed beneath the bed of the truck at the back end. When all was ready, the driver raised the pole by the motor and winch and backed up the truck until the rear wheels struck the curb. The pole was steadied, against falling at right angles to the street, by a pike pole above and a piece of steel stuck into the pole below and fastened to the truck bed. The jack under the end of the truck was allowed to topple over during the backing movement.

*1801 East 93d St., Cleveland, Ohio.

Co-operation on Construction Work between Engineers and Contractors

By J. C. Lathrop*

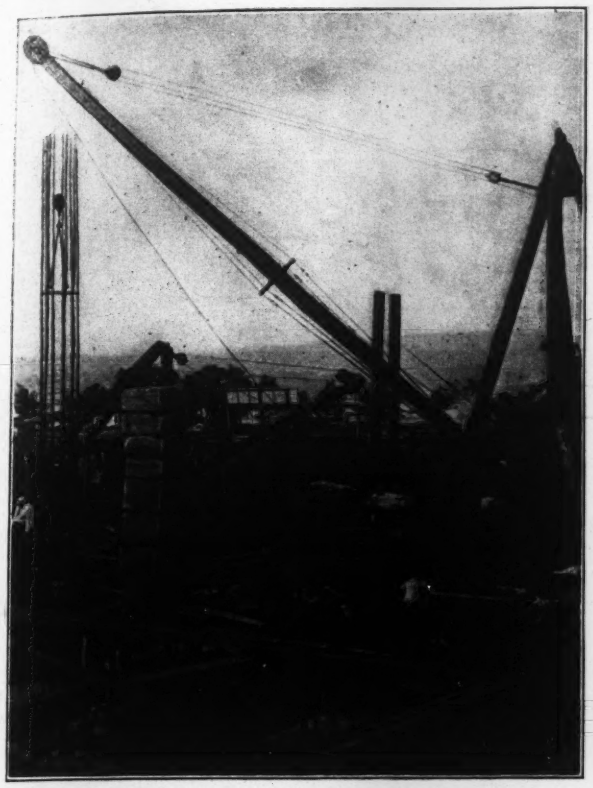
During the construction of a new boiler house for the Consolidated Gas, Electric Light & Power Co., Baltimore, and after the steel frame was erected, a 3-ton jib crane so arranged that it would swing over the B. & O. siding adjacent to this plant and deliver material to the main boiler-room floor 20 ft. above this track was a decided help to all contractors, as well as to the company.

As the columns adjacent to this siding are designed to support a very large load in the future but are now carrying practically nothing, it was safe to attach the crane to one of these columns, in the manner shown on the accompanying photograph. A certain amount of the temporary covering for this side of the building was omitted until the completion of the building.

Jib Crane Put Up for a Company Job, and Later Used by Various Contractors to the Advantage of All Concerned

This crane was installed by the company for the use of the company's men while unloading parts of six Taylor stokers. There were but nine carloads of this material and it was not thought necessary to buy an elec-

*Consulting Engineer, Consolidated Gas, Electric Light & Power Co., Baltimore, Md.



FOUNDATION WORK IN THE LINCOLN MEMORIAL

tric-driven chain block for this work. A chain hoist was used for the heavier pieces and the light material was raised with a block and tackle. If the amount of work which this crane was called upon to perform had been anticipated in the beginning, it would have been a decidedly good investment to have purchased an electric chain hoist.

In addition to the stoker parts above mentioned, the contractor for the boilers used this crane in raising a large amount of minor material, the heavier parts of the boilers having been raised earlier by means of a derrick which the steel contractor had on the work. The contractor for the piping used the crane for raising all piping which went above the main boiler-room floor. The photograph shows this contractor raising a large section of 36-in. atmospheric exhaust pipe. As this work was done on the basis of cost plus a percentage, any saving was directly advantageous to the company.

The contractor for the boiler breeching unloaded all material and placed it upon the main boiler-room floor with the crane.

Numerous miscellaneous items which were to be erected in the boiler room above the main floor, such as coal chutes, minor beams, walkways, coal scales, etc., were unloaded from the cars and placed on the floor by the crane.

The above experience would indicate that better cooperation between the owners and the numerous contractors employed on a job of this magnitude would lead to better returns, for the following reasons:

First, if the owner or his engineer when asking for proposals would state what tools and facilities of that nature would be provided by the owner, it should lead to a considerable reduction in the prices quoted.

Second, the relation of the various contractors could be better controlled by the engineer in charge.

Third, a progress schedule prepared by the engineer could be held to much more closely than is usually the case, for it could be understood in the beginning that if the contractor or manufacturer was not ready to use the facilities provided by the owner at the time specified in the contract, he should forfeit the right to their use. He could then use them at night or at the discretion of the engineer. Doubtless, many unforeseen obstacles would prevent the exact working out of such a schedule and the control of these tools would necessarily be left more or less to the engineer in charge.

Sinking Cylinder Piers for the Lincoln Memorial

The accompanying view is from a recent photograph of the foundation work for the Lincoln Memorial on the banks of the Potomac River, at Washington, D. C. As described in our issue of May 7, 1914, p. 1910, this memorial to Abraham Lincoln is to be in the form of a Grecian temple and the superstructure is to be carried through the medium of a concrete substructure and a number of reinforced-concrete piers reaching down to bedrock some 40 to 50 ft. below the present surface. These piers are being sunk by the cylinder-pier method; that is, by excavating inside a weighted steel cylinder and adding upper sections to the cylinder as it sinks under the weight. After the cylinders reach rock they are filled with concrete reinforced with vertical twisted steel rods held in place by a spiral of steel.

In the view, a number of the footings may be noted. At the far left a reinforcing unit is just being dropped into an already sunk cylinder and just to the right of the spiral is shown the loading of another cylinder. In the foreground, the reinforced-concrete caps of the cylinders which have reached bottom are shown.

The work is being carried on by the Lincoln Memorial Commission with the engineering part under the direction of Col. W. W. Harts, U. S. Army. M. F. Comer & Co., Toledo, Ohio, are contractors for the substructure.

A Simple Instrument for Measuring the Deflection of Bridges and Structures, which has been quite extensively used in Europe, but until now has not been put on the American market, is called the deflectometer. This instrument consists merely of a revolving dial, about 5 in. in diameter, a pointer, a central pulley geared to the axis of the dial, and an idler pulley, which may or may not be used. There are two ways of using the instrument, either placing it on the structure, the deflections of which are to be measured, or on an adjacent rigid support. A steel tape or belt passes over one or both pulleys, and it is the movement of this tape which is magnified on the dial scale. When the instrument is placed on the structure one end of the tape is fastened rigidly below, to a buried weight or other anchor. The other end of the tape, after passing over the pulley, is attached to a weight, which is free to rise and fall. If the instrument is on a separate rigid support, the end of the tape is attached to the deflecting structure by a clamp, instead of being anchored. All movements of the tape are transmitted to a circular motion of the dial, a pin projection on which moves the pointer to ther scale reading. The pointer remains at the scale reading after the dial moves back, as it, of course, does when the load is taken off the structure. The instrument can measure the movement, vertical or horizontal, of any structure or part of a structure to 0.01 mm. The deflectometer is the invention of Wilhelm Fentzloff, Frankfort-on-Main, Germany, and is being introduced in this country by F. J. Bernard, 70 Murray St., New York City.

Rapid Rechaining for Railway Appraisal

A part of the work of valuing the railways of the United States now in progress under direction of the Interstate Commerce Commission consists in accurately measuring the length of all the railways in the United States. As the length of sidings and spur tracks as well as main tracks has to be measured, this means the measurement of lines over 350,000 miles in length.

The first tentative draft of the instructions for roadway and track field parties, issued by the Commission Apr. 24, specified that the measurement shall be done carefully and accurately with a steel tape measuring continuously along one of the nearest rails. This measurement is to be transferred to the base line, which on single-track road is central between the rails and on double-track roads is located midway between the two main tracks.

If measuring the length of the lines were all that was necessary for the valuation work, this length could be ascertained at a small fraction of the cost involved in the chaining by designing a simple odometer, merely an idler wheel flanged to run on the rail and drawn along the track by a velocipede car or section motor car. With accurate calibration of the instrument and care in accelerating and stopping the machine, results of very high accuracy could doubtless be attained.

The survey parties, however, are required to mark all 100-ft. stations on the web or base of the rail, and the survey notes have to locate by stations and pluses all culverts, trestles, bridges, intersections of state, county, township and other lines, etc. The chaining is therefore necessary anyway. The odometer measurement, above suggested, however, might serve as a valuable check against errors of magnitude in the chaining.

A Temporary Sand-Bag Dam

In the improvement of the new Beargrass Creek channel (for an open storm-water channel) at Louisville, Ky., a sand-bag dam was built at the junction of the South Fork and Middle Fork for the purpose of diverting the flow of the creek to an intercepting sewer during construction work below this point.

The dam as first built is shown in Fig. 1, and was intended to be strong enough to stand during the lighter storms only, and to fail in storms severe enough to cause freshets endangering property above. During the construction work, the dam was washed out six times.

The width of the creek at the site of the dam was about 40 ft. but the dam was extended at the top to a length of about 50 ft. It had a height of about 6 ft. For the first construction, the dam had two sets of vertical planking driven against horizontal timbers into the bed of the creek, to prevent underflow. The two rows of planking (which show in the view) were about 5 ft. apart, and the space between them was filled with sand bags. The sacks used for the dam were of about 2 cu.ft. capacity, but were filled only two-thirds full, using sandy clay found near the work.

In order to obtain a dam of greater stability, some modifications were adopted upon its reconstruction. The most substantial style of dam was built of a trapezoidal section and the sand-bags were protected by [illegible] timber aprons spiked to a heavy timber framework and secured at the bottom to sills set in the bed of the creek. The downstream face or apron was inclined at a slope of 1½ vertical to 1 horizontal; the upstream face was [illegible]

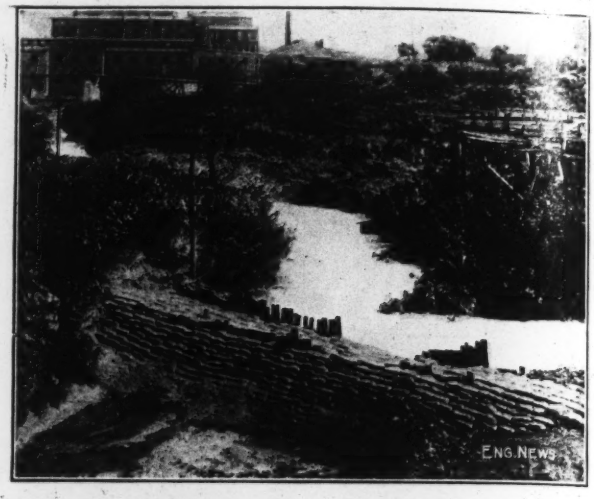


FIG. 1. FIRST CONSTRUCTION OF TEMPORARY SAND-BAG DAM ON BEARGRASS CREEK AT LOUISVILLE, KY.

FIG. 2. RECONSTRUCTION OF TEMPORARY SAND-BAG DAM, WITH PLANK COVERING

what steeper. The completed dam as built in this way is shown in Fig. 2. For information we are indebted to J. H. Kimball, consulting engineer, Louisville Trust Bldg., Louisville, Ky.

Shoring Difficulties in St. Louis Sewer Construction

BY CHARLES C. PHELPS*

The Apr. 16 issue of ENGINEERING NEWS contains an article describing very fully the reconstructed Rocky Branch Sewer in St. Louis, Mo. Not the least of the difficulties in carrying on this work was in connection with the shoring of the trench by means of sheet-piling. Both sides of the streets through which the sewer passes are built up with residences and stores, and in many places

*Ingersoll-Rand Co., 11 Broadway, New York City.

the material excavated was of loose nature, such as wet and dry sand, as well as quicksand.

The work is near completion on the round, 14-ft. brick sewer. Steel sheet-piling is driven to a depth of 40 ft. or more by means of extension pieces; steam piledrivers on derricks having 50-ft. booms, are employed. Excavation is accomplished by a steam crane with bucket. As the earth is removed, the sheet-piling is strongly braced lengthwise and crosswise by heavy timbers.

After excavating nearly to quicksand, special precautions are necessary, not only to protect adjacent property but also to make further operations possible. Bulkheads of plank piling are built across the trench every 20 ft. or so. These are 24 ft. high and are driven about 9 ft. below subgrade. The bulkhead, 8 in. thick, is composed of bolted tongue-and-groove piles. The details of the shoring are well illustrated in Fig. 1. With such an arrangement, it is comparatively simple to keep the trench dry and proceed with the work of laying the sewer.

As the completed masonry nears one of these bulkheads, it is not feasible to pull the plank piling until the fill has been at least partly completed, as the heavy cross timbers are partly braced by the piling and must be left to support the steel piling at the sides. The expedient adopted as most practical was to cut off the bulkhead piling slightly below grade and also just below the lower wale, which allows sufficient clearance for the masonry work.

The first attempt was to cut off these piles with an ax, but this method was found to be extremely slow and difficult. Large wood chisels fitted to special pneumatic hammers were next tried but without satisfactory results. Circular saws were also considered, but were discarded as being unsafe. Then a 1¾-in. wood-boring auger, operated by a No. 13 size "Little David" compressed-air drill motor, was tried and found to be a very practical means for cutting these thick planks. This motor requires about 30 cu.ft. of free air per minute, which was furnished by a Westinghouse air-brake pump. About seven holes of this size are required to sever a pile and the time consumed in boring each of these 8-in. holes is from 20 to 25 sec. Two or three are required to cut across the pile, so that the entire time consumed in making both cuts across the trench figures ordinarily, between 1½ and 2 hr. The cutting is often in awkward locations and sometimes the tool has to be operated under water.

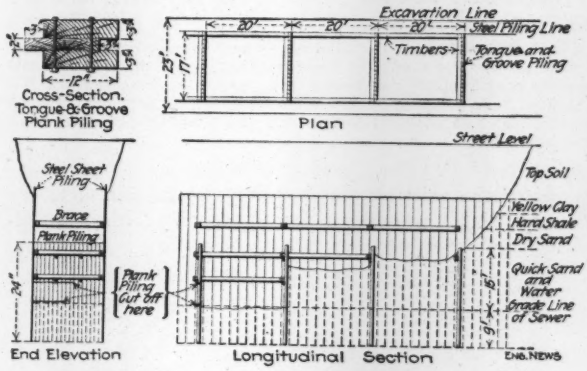


FIG. 1. SHORING AND BULKHEADS IN ST. LOUIS SEWER TRENCHES

Similar methods were employed on another part of the sewer which has been completed. There the sewer is rectangular in section to save headroom. On that section about 15 ft. of the lower part of the excavation was quicksand. Side piling, composed of 6x12-in. by 20-ft. planks, was driven down 6 ft. below subgrade and served not only as a bracing for the excavation, but also as the outside form for the concrete.

After the concrete had set, these piles had to be removed or cut off just below the street grade. As they were embedded quite deeply and were needed to prevent settlement of the adjacent ground, it was impractical to remove them, and the city permitted the contractor to leave them after cutting off the upper ends. There were about 1500 of these piles and a pneumatic wood auger was employed, as previously explained, for cutting off the piles about 10 in. below the pavement. It required from 16 to 20 sec. to bore each 6-in. hole, making the time for boring 7 holes, to cut one pile, 1¾ to 2½ min.

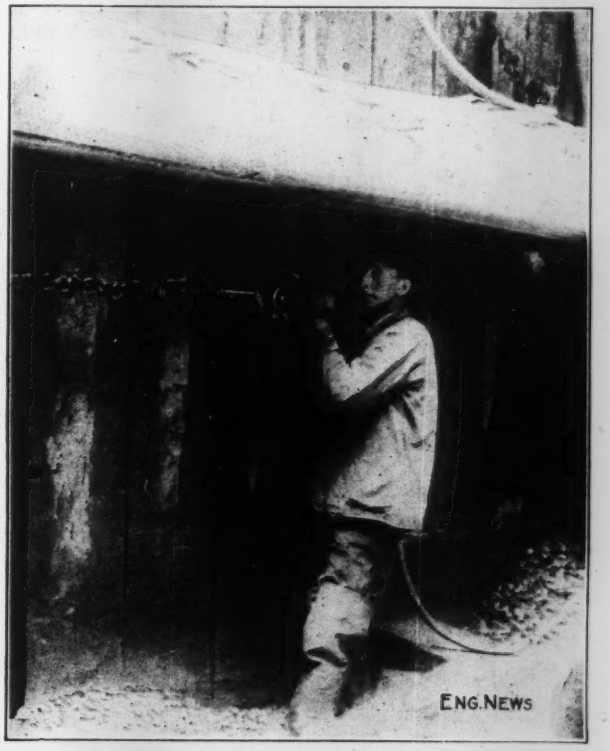


FIG. 2. CUTTING OFF THE TIMBER BULKHEAD PILING
(Shows the upper cut, just below the lower wale. The lower cut is hidden by the material on the floor. A small section of the sheet piling is shown at the extreme right.)

The above described work was done by the James Black Masonry & Contracting Co., of St. Louis. The writer is indebted to G. W. Winslow, of St. Louis, for most of the data contained herein, as well as the view.

A Reversible Section Liner—The "Sphinx" section liner, made by F. Weber & Co., Philadelphia, Penn., is now made in a reversible type, that is, the spacing apparatus made be made to operate either from right to left or from left to right. The 7-in. beveled arm may be set at any angle. The reversible section liner costs $1.75, or 25c. more than the single-action kind.

A Record of 65 Years' Progress in City Surveying: St. Paul, Minn.*

In 1849 when the village of St. Paul was incorporated, property ownership was based on claim lines. In 1853 the United States completed the subdivision of the territory now covered by the city, and since that time subdivision lines have been based on these township and section lines, excepting where claim lines existed.

Between the years 1885 and 1890, all of the section lines within the city limits were rerun with transit and steel tape, and all section and quarter-section corners were marked with granite monuments. At the same time all streets were resurveyed and monumented, so that a complete survey of the then existing, laid-out portion of the city's entire area was made and mapped on a scale of 100 ft. = 1 in.

All existing platting was shown on these maps with record distances, and also the resurveyed distances with monuments. These maps were called Standard maps and were made on mounted eggshell, each map covering one mile east and west and one-half mile north and south. There is a total of 118 of these maps. They were public records and were used continually by outside surveyors, real-estate men, etc., as well as by employees of the City Engineer's office.

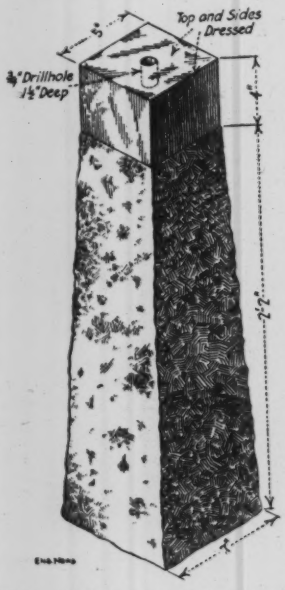


FIG. 1. STANDARD GRANITE MONUMENT FOR STREET BOUNDS, ST. PAUL, MINN.

As these maps became badly worn an attempt was made in 1902 and 1903 to trace them, but it was found impractical as so many of the lines had been obliterated by use and, furthermore, a great many errors had been made in the filling-in, in the original platting. It was then decided to redraw them from the original notes on heavy, detail paper, trace these drawings and blueprint them; the blueprints were to be used by the public and the original drawings to be preserved.

MONUMENTS—Prior to 1881 all additions to the city were marked with wooden hubs, but since that date all block corners in new additions have been marked with iron pipe, in accordance with a state law. The additions have been laid out with reference to the section lines, and section lines have become the center lines of the present street system except where claim lines existed. As streets were improved these iron pipes were replaced by standard granite monuments (Fig. 1), either at the location of the iron or at the street intersection; now 90% of the streets are sufficiently well monumented to make the running out of a street line a simple matter. Fig. 2 shows method of locating and referencing monuments.

*From recent reports of the Commissioner of Public Works, Oscar Claussen, St. Paul, Minn.

As additions or rearrangements are platted and recorded in the Registry of Deeds office they are put on the Standard maps and after streets are improved they are monumented and the monuments are also shown on the Standard maps.

For a great many years a monument atlas was kept up, and it was necessary to refer to this atlas when monuments in any particular locality were required. Monuments were numbered and the number referred to the page of the monument record book on which were given the notes and ties required.

This monument record, for some reason, fell into disuse and it has also been found that the records on the Standard maps for the last few years are not complete. To remedy this a card-index monument record has been started with the intention of bringing up to date all records of monuments in the city. These cards are indexed under the street name. There are three or more intersections to each card and the cards are numbered and run consecutively on each street from the center of the city outward. These cards are also used for records of roadway widths.

The monuments themselves received no better care than the records. A great many of them were taken out or disturbed during construction work, such as grading streets, putting in sewers, and then not replaced. Some of the monuments were taken out by contractors under instructions from the street engineer because it could not be avoided, but the department was lax in not having them replaced as soon as the construction work was completed.

Specifications in all contracts for city work have the following clause:

The contractor shall not disturb any monuments or stakes found on the line of the improvement until ordered by the engineer and shall reset any monument as directed by the engineer. A penalty of $25 may be imposed for each monument disturbed without orders and the amount deducted from the estimate.

ADDITION PLATS—All plats of additions or rearrangements of the existing platting must be submitted to the County Plat Commission for approval. This commission has jurisdiction over the arrangement of streets and alleys, their width, and their connection with existing streets and alleys; the placing of monuments, the correctness of the survey and the placing of all data on the plat necessary to retrace it in part or in whole on the ground.

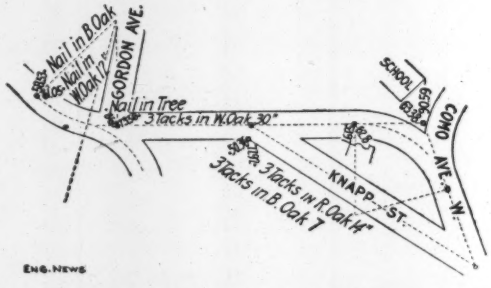


FIG. 2. METHOD OF SETTING AND REFERENCING STREET MONUMENTS, ST. PAUL, MINN.

When surveys are necessary to check the accuracy of the work they are made by the City Engineer upon request of the Plat Commission when within the city limits

and by the County Surveyor when outside the city limits and within the county.

The Commission also sees to the compliance with the law regarding size of plats, quality of paper, character of drawing, form of affidavit, descriptions, dedications and acknowledgments. It is also the business of the Commission to see that a copy of the plat is made and filed in the City Engineer's office before the original is placed on record.

Hydrographic Surveying with a Four-Man Party

By B. L. Rees*

Some time ago, while the writer was in charge of some harbor work in the South for a private concern, it became necessary to take a series of off-shore soundings, where the method of locating soundings from two transit stations on shore was the only one applicable. The available party consisted of only one assistant engineer, a transitman, a laborer for a boatman, and the writer as the second transitman.

The results were very satisfactory, and the work was done rapidly. A party of four is believed to be the smallest possible for such work, and as some of the methods and equipment employed were unique but practical, a detailed description of both is here given.

Special Sounding Line—The usual cotton-cord sounding line was not used because of its variable length. A brass "jack" chain was substituted. The links of this chain are in the form of a figure 8 with one half of the link bent at right angles to the other. This type of chain does not kink readily and is easily handled, while it has the advantage of constant length, thus avoiding a variable correction.

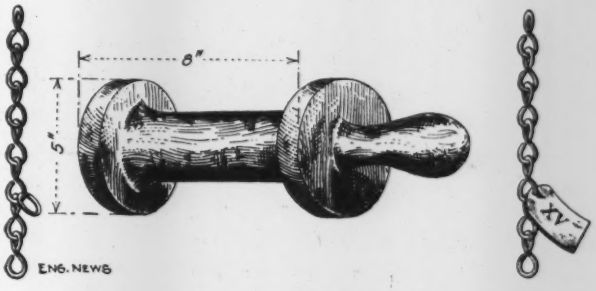
A good-sized chain for sounding purposes will run from 5 to 8 ft. to 1 lb. The foot marks were galvanized-iron rings about ½ in. in diameter, although brass is preferable when brass rings can be obtained. The 5-ft. marks were small strips of rawhide into which Roman numerals were burned with an iron. Circular brass tags about ⅝ in. diameter are preferable when obtainable. The chain was not used for casting, but the writer can see no objection to the use of such a sounding line when casting is necessary.

Tide Gage—The tidal range averaged about 8 ft. A tide gage was set where it could be readily observed by one of the instrumentmen while the soundings were being taken, although the work was generally done about slack low water.

Sounding Boat and Crew—An ordinary flat-bottom row boat, locally called a "bateau," with a single oarsman, was used. The leadsman did his own recording on manila cards 6x10 in., made fast by thumb tacks to the bottom of a shallow box which rested on the stern seat in front of him, while he was sounding. These cards were properly ruled and the lines numbered consecutively. As soon as the leadsman had completed his work, his records of soundings, necessarily wet and soiled, were immediately transferred to one of the transit books, checked, and the cards destroyed.

Whistle Signals—Next to the sounding chain, the most important item of the leadsman's equipment was a standard police whistle. With this whistle held in his mouth, he blew a signal whenever a sounding was taken. This "whistle method" replaced the usual method of timing soundings. The writer believes this whistle method has many obvious advantages over the time method, particularly since soundings can then be taken when possible—a very decided advantage in rough or flowing water. Where the leadsman is so far from the instruments that such a whistle is impractical, the body of water will necessarily be of a size requiring a power-boat and a flag or other flash signal will answer the same purpose. An extra or fifth man might be required in such a case.

Field Methods—The leadsman stood in the stern of the "bateau" facing back and had the box of record cards



Chain and Reel Used in Four-Man Sounding

before him on the seat. When ready to take a sounding, he suspended the lead-chain over the side of the boat toward the instrumentmen. Both instruments were then sighted to the chain at the water surface, and the alidades turned to follow the chain as the leadsman moved it slowly around and off the stern.

As the lead touched bottom, the leadsman blew the whistle and both instrument alidades were stopped at that position. He blew once for each sounding except the fifth, when two blasts were given; and in this manner the three men had a check, which was signaled back to the leadsman in the boat by the instrumentmen using the regular arm signals.

While the leadsman was recording his soundings and moving to another position, the instrumentmen read and recorded the horizontal angles and observed the tide gage.

The advantages of this method were: the leadsman gave the signal promptly and avoided the delay of telling a second man to signal; he took the soundings to the best advantage without regard to any time interval, working slower when required and making up for it when possible; an extra man in the boat as recorder and for signaling was eliminated and the instrumentmen did not have to read watches and record sounding time. There was no difficulty in taking soundings at the rate of two to the minute, at times; yet at other times, there were delays of several minutes.

Transit Stations—Two transits were used in the regular way at established stations. They were properly oriented and with the upper motion clamped only sufficiently to hold any set position, the instrumentman followed the suspended sounding chain until the leadsman by blowing his whistle gave notice of a sounding, when the alidades were stopped and the horizontal angles read and recorded.

*Assistant Engineer, Public Service Commission, 1138 Whitehall Bldg., New York City.

Each transitman had the regulation transit fieldbook, with lines numbered consecutively to check with the leadsman's signal at each fifth sounding. One of the books was ruled to show, in addition, the tide-gage reading, which was recorded for a change of a tenth. In addition to these columns, for horizontal angles and gage readings, columns were prepared for recording the soundings transferred from the leadsman's cards, and another for these soundings when reduced to mean low-water datum.

Illinois Road Cross-Sections

Standard cross-sections of Illinois state-aid roads are divided into two general types: those for the single-track roads, and those for double-track roads, with intermediate forms as noted below.

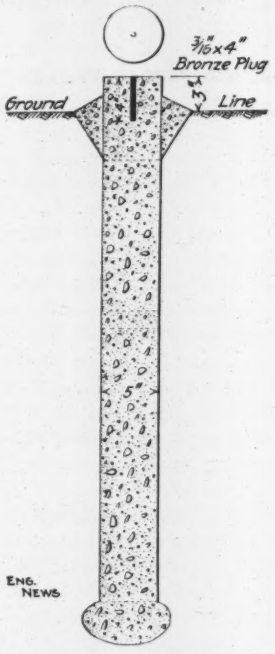
Where it is decided that the traffic will be accommodated by a single-track road, the paved portion is 10 ft. wide, if constructed of concrete or brick. This width is sufficient for a single line of vehicles and will also permit two vehicles to pass with only two wheels of one of the vehicles off the paved portion of the road, the other having all four wheels on the paved road. A modification of this section, offering a somewhat greater convenience than the single-track road alone, are the sections which provide in addition to the 10-ft. paved portion of concrete or brick, 4-ft. macadam shoulders on either side. It is anticipated, however, that this section in first construction will be used only on those roads where it may seem that double-track roads should be provided but, owing to the limited funds that may be at hand, together with a doubt that might exist as to the necessity for the double-track road, it is decided not to build an 18-ft. double-track road. Usually the macadam shoulders will not be provided in first construction, as they may be placed fully as cheaply after the road is built and when the traffic needs demonstrate the necessity for them.

As all the principal roads now carry a considerable proportion of motor traffic, and moreover as this proportion of motor traffic is fast increasing, it is necessary to take this fact into consideration in the proper design of the road. Experience has proved that to provide safely for two lines of mixed traffic, 18 ft. is the minimum width. It is apparent, therefore, that any width between 10 ft. and 18 ft. is uneconomical, because the traffic either requires the double-track road and therefore the road is too narrow for the traffic, or the traffic does not require a double-track road, in which case it is wider than is necessary.

The single-track roads for macadam construction, which will be used to some extent on the lesser traveled roads in the south portion of the state, provide 12 ft. for a single-track road. The reason for a 12-ft. macadam rather than a 10-ft., is that the traffic on the 12-ft. road will tend to spread itself somewhat more evenly over the surface of the road and therefore not confine the wear so nearly in one track as would be the case if a narrower road were built. With the hard brick or concrete surface, which will resist the wear, it is not so important that the traffic spread over the road as in the case of a macadam surface. [A. N. Johnson, recently Chief Engineer, Illinois Highway Commission, in the June Bulletin of the Highway Department.]

Permanent Survey Monument for Southern Louisiana Reclamation Projects

A concrete survey monument, which has been used with success for marking important property corners in marsh-land in southern Louisiana, is illustrated in the accompanying sketch. It is built of cement mortar in a form made of common 5-in. iron stove-pipe. The sand and cement are mixed dry, two parts sand and one part portland cement, packed in cement sacks, each sack holding 0.75 cu.ft., and carried into the field. Two sacks are required to make one monument.



CONCRETE MONUMENT DESIGNED BY ARTHUR M. SHAW, NEW ORLEANS, LA.

Two lengths of stove-pipe are placed in the hole. The mortar is mixed moderately thick; in marshy ground a rammer is used to crowd out a small amount of mortar at the bottom to form a spread base. After the hole is backfilled with carefully tamped earth, the remaining mortar is deposited around the top of the monument as shown. A $\frac{3}{16}$x4-in. bronze bolt is pushed into the soft mortar flush with the top of the monument. The pipe is left in the ground.

The advantages of this type of survey marker are: permanence, easy construction by ordinary laborers, easy transportation of materials, readiness with which the materials may be secured and their cheapness; the pipe forms are the cheapest grade of black iron stove-pipe, which comes "nested" in convenient shape.

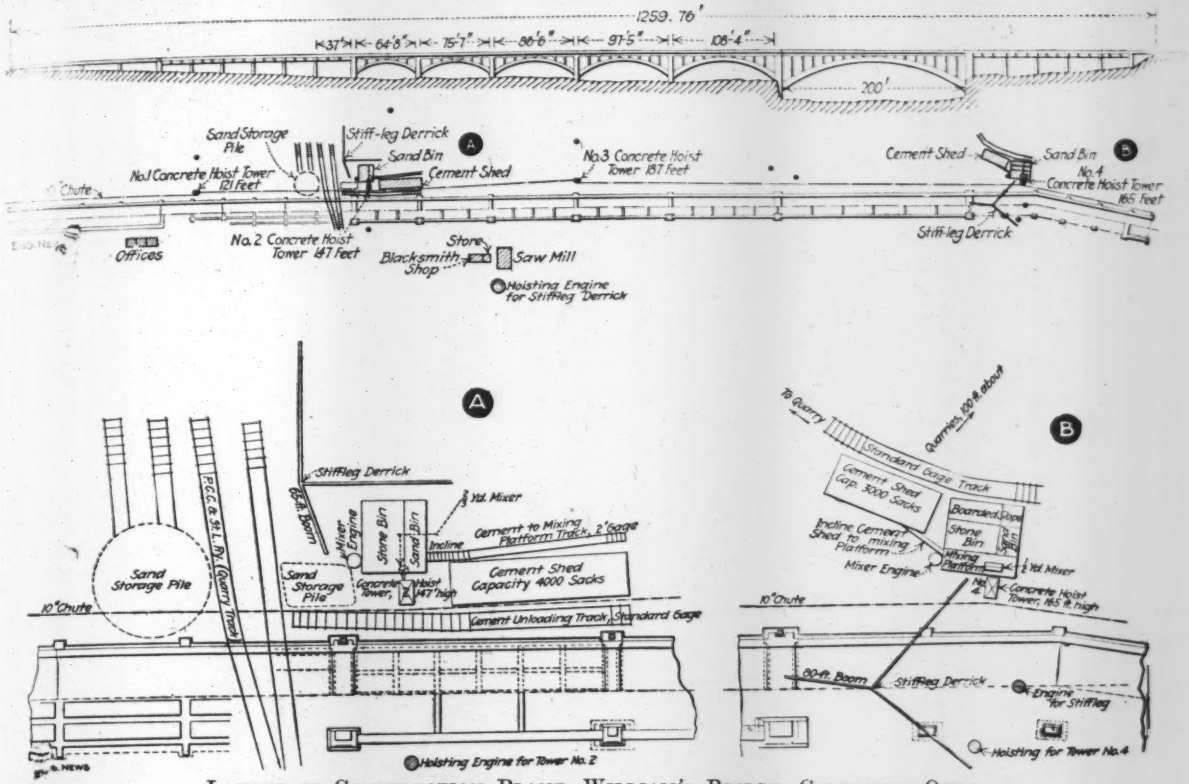
Iron pipes have been extensively used for markers in similar land; but even galvanized-iron rusts very rapidly, this distinction being most pronounced at the ground surface. Black iron pipe could not be depended upon in such locations to last more than two or three years. The monument shown was devised by Arthur M. Shaw, 1003 Hibernia Bldg., New Orleans, La.

Construction-Plant Layout for a 1200-Ft. Concrete Arch Bridge

BY E. P. KNOLLMAN*

A concrete bridge, known as the Williams Bridge, is now under construction over the Scioto River in Franklin Count, Ohio. The bridge is located at Marble Cliff, several miles northwest of Columbus, and is to replace an old wooden structure carried out by the flood of March, 1913. The new bridge has a total length of 1263 ft. 3 in., and is 33 ft. wide over all, with a 24-ft. roadway and two

*Resident Engineer, 30 East Lane Ave., Columbus, Ohio.



LAYOUT OF CONSTRUCTION PLANT, WILLIAM'S BRIDGE, COLUMBUS, OHIO

2-ft. sidewalks. It has six arches of the ribbed type with varying spans, the main arch over the river having a clear span of 195 ft. At either end of the arch spans are several girder spans, and retaining-wall abutments. The concrete, exclusive of the railings, totals 4750 cu.yd.

At the present time most of the construction equipment has been installed. The east retaining-wall, east girder spans, and some of the arch piers, have been poured, and work is progressing westward. The drawing herewith shows the layout of the plant.

The main concrete-mixing plant is on the east side of the river near Pier 6. Here a stiff-leg derrick with 65-ft. boom is installed, commanding the quarry tracks, on which the materials are delivered. It operates a clam-shell bucket with which the sand and stone are unloaded from cars and delivered to hopper-bottom storage bins, discharging by gravity to a measuring bin above a ¾-yd. Cube mixer. Incoming cement is unloaded from cars onto small push cars which deliver the cement to a shed, having a capacity of 4000 sacks. Cement from the shed is loaded into a car, pulled up an inclined track by means of a hoist on the mixer, and dumped onto the platform.

Concrete is elevated in Tower 2 (147 ft. high), and is delivered through chutes to a bucket in Tower 1 (121 ft. high), or to one in Tower 3 (187 ft. high), or direct to the bridge. At Towers 1 and 3, the concrete is again elevated and delivered through chutes to the various parts of the bridge.

This east-side mixing plant is to supply all the concrete required for that part of the bridge east of a point 20 ft. west of Pier 11.

There is an auxiliary concrete-mixing plant now being installed on the west side of the river. Here crushed limestone will be delivered in small side-dump cars directly from the quarries, which are in the immediate vicinity. The stone and sand will be dumped into bins discharging by gravity to a measuring hopper above a ½-yd. Ransome mixer. The cement will be unloaded into a shed having a capacity of 3000 sacks and, as needed, will be delivered by gravity to the mixing platform. The concrete is elevated in Tower 4 (165 ft. high) and chuted.

The chutes, hoppers, etc., are standard Insley equipment. Steel cables ⅞ in. in diameter are stretched over the tops of the towers to deadmen. From the cables, 10-in. chutes, inclined 30° with the horizontal, are hung on ¾-in. manila rope suspenders. Tower 3, which is a typical one, is 3½x6 ft. in plan and has four 6x6-in. posts braced with 2x10-in. transverse and 2x6-in. diagonal planks, all connections being bolted. Each tower has four sets of four guys.

Water is pumped from the river to a tank located on a large pile of quarry waste and is distributed by gravity.

The 225 tons of reinforcing steel are bent by hand on the job.

The arch piers are being constructed in open sheeted excavations which are carried to bedrock. The maximum depth of excavation is about 35 ft. The excavating for all the arch piers except 11 and 12 is being done by means of a stiff-leg derrick, with 40-ft. boom and ¾-yd. buckets. Derricks with 80-ft. booms are installed near Piers 11 and 12 and will be used to remove the sandstone abutments and pier of the old bridge, to excavate, and to drive the piling for the centering of the main arch.

The contractor for the bridge is D. W. McGrath; E. C. Miller is contractor's superintendent. John Peake is County Surveyor, Walter Braun is County Bridge Engineer, W. J. Watson & Co. are the consulting engineers, and the writer is Resident Engineer.

Load-Tests on Concrete Piles, North Side Point Bridge Approach, Pittsburgh

An acceptance load-test of the concrete piles used for the foundation of the piers of the approaches to the North Side Point Bridge, Pittsburgh, Penn., was made on one pile in each of the eight pier bases. The tests were made under the specifications of the Director of Public Works of the city of Pittsburgh by the Raymond Concrete Pile Co., whose familiar cast-in-place concrete piles were used on the work.

The approach piers are founded in a sedimentary deposit of sand and loam, overlying a gravel bottom, into which it is quite difficult to drive or sink piles. Consequently the piles were short, the piles varying in length from 12 to 23 ft. and averaging about 17 ft. They were uniformly 8 in. in diameter at the point and increased in diameter toward the top at a rate of 0.4 in. per foot of length. The specifications under which these tests were made are as follows:

TIME OF TESTING—The contractor shall drive all piles in such a manner and to such a depth that they will withstand the following tests 30 days after the concrete has been placed in the piles.

NUMBER OF PILES TESTED—One pile in each group or pier base will be selected by the director for testing. In case any or all the piles tested fail to fulfill the requirements hereinafter specified the contractor shall, if ordered by the director, make tests of other piles in the groups in which the tests have failed, without additional compensation. All piles for testing shall be selected by the director.

ADDITIONAL PILES—In cases where the tests of a group shall fail to meet the hereinafter specified requirements, the entire group in which said test piles are located shall be considered the same as the test pile, and their safe carrying capacity shall be considered one-half the load of said test pile when it gave a settlement of ⅜ in., and the contractor shall drive such additional piles and at such locations and depths as ordered by the director.

Additional piles made necessary due to failure of test piles to sustain the specified test shall be driven where directed by the director and to penetration of surrounding piles at the expense of the contractor.

PREPARATION OF PILES FOR TEST—The piles selected to be tested shall have placed in their top a suitable steel dowel or plug, securely grouted in place, with its top round, and the test loads shall be so placed that a level rod can be set on the plug at any or all times.

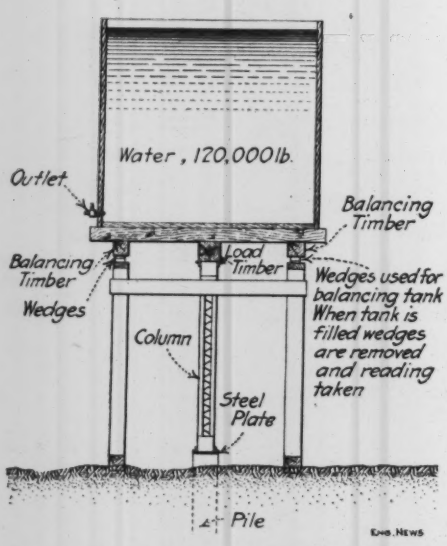


FIG. 1. METHOD OF SUPPORTING 60-TON LOAD ON TEST PILE

FIG. 2. ONE OF THE PILES UNDER TEST

Upon the pile shall be placed a suitable platform properly balanced, so that the test load acts vertically on the pile.

LOADS—Upon this platform there shall be placed a load of 30 tons, which shall remain undisturbed for 36 hours; the load shall then be increased to 60 tons and allowed to remain undisturbed for 36 hours. The load shall then be removed.

READINGS—The following readings shall be taken: First, before any load or platform is placed upon the piles; second, immediately after the 30-ton load has been placed upon the pile; third, 36 hours after the 30-ton load was placed upon the pile; fourth, when the 40-ton load has been placed upon the pile; fifth, when the 50-ton load has been placed on the pile;

TABLE OF RESULTS OF PILE TESTS, NORTH SIDE POINT BRIDGE, PITTSBURGH

Pile No.	88	48	68	80	85	45	57	51
Pier No.	2	1	6	7	8	9	10	11
Length	22′–9″	17′–3″	14′–1″	12′–11″	15′–0″	17′–9″	21′–7″	22′–4″
Date driven	4–2–14	3–16–14	6–3–14	5–25–14	5–19–14	5–12–14	5–4–14	4–27–14
Date test begun	5–2–14	4–14–14	7–13–14	7–6–14	6–26–14	6–15–14	6–2–14	5–23–14
Elapsed time, days	30	28	40	42	36	33	28	26
Date test completed	5–8–14	4–22–14	7–18–14	7–11–14	7–3–14	6–20–14	6–8–14	5–29–14
Elapsed time, days	6	8	5	6	7	5	6	6
Settlement under 30 tons, ft.	0.004	0.005	0.007	0.006	0.005	0.002	0.003	0.003
Settlement under 60 tons, ft.	0.013	0.021	0.015	0.023	0.016	0.009	0.015	0.009
Area of pile in ground in sq.ft.	67	46	37	32	40	50	64.5	69
Pounds load per sq.ft. of pile area, inc. point	1800	2609	3241	3715	3000	2400	1860	1740
Pounds load per lin.ft. of pile length	5770	7500	9231	10,084	8571	7143	5820	5760

sixth, immediately after the 60-ton load has been placed on the pile; seventh, 36 hours after the 60-ton load was placed on the pile; eighth, when the load on the pile has been reduced to 30 tons; and ninth, immediately after the entire load and platform have been removed from the pile.

ALLOWED SETTLEMENT—The pile, to be acceptable, must not show a settlement exceeding ¼ in. between the first and third readings, or a settlement exceeding ⅜ in. between the first and seventh readings, or a variation between the first and ninth readings exceeding $\frac{1}{16}$ in.

BEARING POWER—The bearing power of each group of piles will be determined by the director from all available data for each particular group and will be based on one-half the load which causes a settlement of ⅜ in.

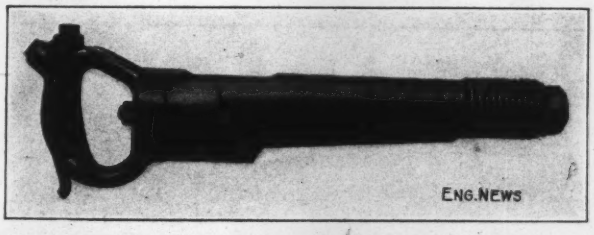
The accompanying diagram, Fig. 1, shows the testing rig. First, a circular steel plate was grouted on to the head of the pile under test and on this was placed a latticed steel column, 13 ft. long, which carried balanced on its top the loading timber on which rested the tank framework. As shown in the view, Fig. 2, side posts were also placed which carried the tank framework, through the medium of wedges, until a balance was attained. When the wedges were struck the tank, carrying the desired load of water, rested on the pile under test. Settlements were read upon a level rod set upon a reinforcing bar which protruded up from the pile through a hole in the plate cap provided for that purpose.

The results of the tests are given in the accompanying table.

The tests were under the direction of N. S. Sprague, Superintendent, Bureau of Engineering, City of Pittsburgh, and under supervision of W. F. Hall, District Manager of the Raymond Concrete Pile Co., for the Pittsburgh District.

NOTES

A Simple Riveting-Set Retainer for preventing accidents consequent to the ejection of the rivet set from the nozzle has been developed by the Ingersoll-Rand Co., 11 Broadway, New York City, for its line of "Little David" pneumatic riveting hammers. The retainer is a steel spiral spring, one end of which fits over a projection on the hammer nozzle; the other end is wound to a smaller diameter, so that the rivet set when for ⅞-in. rivets or smaller can be formed with a shoulder and slipped into the retainer. The larger sizes of riveting sets are formed with a coarse thread and screwed into place. It is claimed that the riveting sets cannot be driven out of the nozzle even when the hammer is run free under 90-lb. pressure per sq.in.



In the Graphical Determination of the Neutral Axis in a reinforced-concrete beam, discussed by Ernest McCullough, in "Engineering News," July 9, 1914, p. 88, a correspondent notes that the method fixes $\frac{k}{1-k} = \frac{n+1}{m+1}$ instead of $\frac{k}{1-k} = \frac{n}{m}$, which is the correct ratio according to the accepted theory. Mr. McCullough explains this discrepancy as follows:

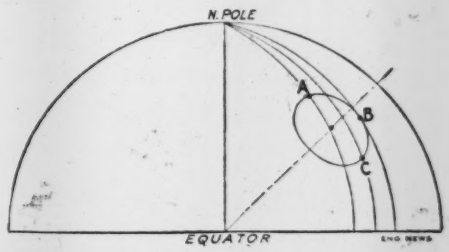
I have been teaching evening students for several years, draftsmen in the offices of architects, engineers and contractors whose mathematical attainments are very limited. With the great amount of free literature floating about it is useless to tell such men not to design, because they will attempt it anyhow. The thing to do is to give them instruction. I found it difficult by using the ordinary mathematical expressions to get into their heads the idea of how two differing ratios, the ratio of deformation and the ratio between stresses, fixed the location of the neutral axis. One evening I drew the two lines on the squared blackboard and the results were so nearly exact that I investigated the matter and found, naturally, that the relations were true. But in handling the students it was still difficult to make many understand where the ratio 1 : 15 and 1 : 24.66 came in without extending the ratio to the left of the line one division. With it in that shape their understanding of the matter seemed complete. The results were as close as ordinary accuracy in design requires, so I have held to this graphical representation in teaching and after the students grasped it showed them the relations actually existing and showed also that by omitting the division to the left of the line the mathematical expression and the graphical representation agreed.

A Problem in Astronomy—A correspondent in Philadelphia, Penn., proposes the following problem, which he has met with in his work, for any of our readers who wish to exercise their ingenuity in spherical trigonometry and astronomy, or solid analytical geometry:

Having given three points, all located in any one quadrant, upon the surface of a sphere, to find the center of the circle passing through the three points.

In the figure, Point A is Lat. 40°-00′ N.
Long. 82°-00′ W.
Point B is Lat. 38°-00′ N.
Long. 82°-00′ W.
Point C is Lat. 39°-00′ N.
Long. 80°-00′ W.

Required to find by a short formula, the latitude and longitude of the point x, the center of the circle, drawn on the surface of the globe, and passing through the points A, B and C.



A Hand Concrete Mixer was used in the construction of the new combined concrete and timber snowsheds of the Great Northern Ry., described in our issue of June 4. While ½-yd. power mixers were used for the heavy work of the retaining walls or back walls, the hand mixer was used extensively in making the concrete for the pedestals which support the timber posts for the roof. This arrangement worked out very conveniently, as the pedestals usually could not be built when the backwall was being built, while the amount of concrete in each was so small and the work so scattered that the concreting could be done in this way more economically than with a power mixer. The machine was built by the T. L. Smith Co., of Milwaukee, Wis., and had a 36-in. drum of about 2½ cu.ft. capacity, 32 in. long, on each end of which was an internal gear meshing with a pinion driven by a crank handle. The charging and dumping were done through openings extending across the drum, and the concrete was dumped directly into the forms, the machine being carried by a pair of 30-in. wheels so that it was easily shifted from place to place.

Designing Shallow Girders for Limited Deflection—R. C. Davis, Chicago, suggests a simple and convenient method for designing shallow girders under the rather common condition that the deflection of such a girder must not exceed the deflection of a girder of particular ratio of depth to span. Many railway specifications for steel bridges contain a clause such as the following:

Plate-girders and rolled beams used as girders shall preferably have a depth of one-twelfth of the span. If shallower girders or beams are used, the section shall be increased so that the maximum deflection will not be greater than if the above limiting ratio had not been exceeded.

In designing a shallow girder under this clause, it is customary to design first a girder having a depth of one-twelfth of the span, determine its moment of inertia, and then design the shallow girder for the same moment of inertia, which will make its deflection the same. Instead of making this double calculation, proceed as follows:

Having given the maximum allowable fiber stress, say 16,000 lb. per sq.in., design the shallow beam or girder in the usual manner, but with a fiber stress reduced in the same proportion as the depth of beam is less than the deeper girder whose deflection is taken as standard. For instance, in a span of 24 ft., if the normal limit is a depth of one-twelfth the span, or 24 in., but local conditions require a girder of 20-in. depth, then design the 20-in. beam for a fiber stress of $\frac{20}{24} \times 16{,}000$ or 13,300 lb. per sq.in. The 20-in. beam

designed in this way will have the same deflection as the 24-in. beam designed for 16,000 lb. per sq.in. Thus the value of $\frac{I}{c}$ will be $\frac{20}{24}$ of that which would be used for a 24-in. beam, and since the half-depth c is also $\frac{20}{24}$ the value of c for the 24-in. beam, the values of I of the two beams will be equal, and this means equal deflections.

An Improvised Gravel and Broken-Stone Spreader—A simple wrought-iron device, designed by a motor truck mechanic and made at a nearby blacksmith's shop, eliminated the labor of several laborers on the construction of a gravel road in Bexar County, Tex. The device is nothing but two simple bar catches, which hold the tailboard of the truck partly open at the bottom, while it remains hinged at the top. The catch has three adjustments for regulating the quantity of stone

PEERLESS MOTOR TRUCK EQUIPPED WITH GRAVEL DUMPING AND SPREADING DEVICE

or gravel dumped. It was found by a few experiments that if the power dumping body was tripped in the usual way, and the truck thrown into the first speed ahead, the material was dumped and at the same time spread evenly to a depth of 6, 8 or 10 in., as the circumstances required. Two Peerless motor trucks were used to haul the gravel, which at first was dumped in piles in the middle of the road. The addition of this simple device saves the labor of three or four shovelers.

Success of a Municipal Ditching Machine—The [illegible] of Worcester, Mass., does practically all its public [illegible] by municipal day labor—and does the work efficiently, [illegible] according views shows a municipally owned Austin [illegible] ing machine at work. The machine was purchased by [illegible] part of the equipment of the city Water Department, [illegible] George W. Batchelder, Water Commissioner, is in [illegible]. The work on which the machine is employed is a 3-ft. [illegible] trench 12 ft. deep in a very hard hardpan containing [illegible] ous small boulders. The ditch was excavated by the [illegible] Department for the Sewer Department at the rate [illegible] per cu.yd., based on a charge of $25 per day. The act[illegible] of operating the ditcher is stated by Mr. Batchelde[illegible] very close to $15 per day. On a water-pipe laying [illegible] trench was dug 6 ft. wide and 6 ft. deep, through various kinds of material, mostly gravel; in an actual operating time of 122 hours 5035 ft., or nearly a mile of trench, was excavated. The trenching machine was recently inspected [illegible] work illustrated by members of the New England [illegible] Works Association, who expressed much satisfaction with its ease of operation and efficiency. Perhaps there is not better proof of Worcester's honest and progressive municipal day-labor administration than the fact that no protests have been received against the introduction of a machine which disposes with the services of several extra laborers.

Ground-Glass Drawing Boards—A sketching board for use in the drafting room in laying out sketches, details and illustrating portions of drawings for detailers, salesmen and customers, is one of the handiest things that a well equipped drafting room can have. Similar in use to the old-fashioned slate, the ground-glass drawing board painted black on one side, serves this purpose admirably.

A fine, evenly ground surface should be used to work on and the reverse side of the glass should be given two or three coats of smooth, black paint. The edges of the glass board should be squared to allow the use of a T-square and triangles. Small slate pencils are best for sketching and should be kept sharp by means of the ordinary sandpaper pad. Erasing is easily accomplished by means of a damp sponge or soft cloth, thus eliminating the dust and dirt incident to art gum or other erasers.

Such a board is especially useful when laying out preliminary sketches which mean constant changing and redrawing. The great saving in drawing and sketching paper is quite obvious. Glass boards up to 2 or 3 ft. square need not be mounted and can be used on any table with the ordinary precautions against breakage. Boards larger than this size should be mounted in a frame and adequately supported in a permanent location. [Frank H. Jones, 95 Partridge Ave., Winter Hill, Mass.]

Stiffleg Derricks are not now in favor with contractors on bridge and steel erection work, according to an erecting engineer. They may be used as yard derricks to unload the steel, but they are too cumbersome for erection, especially on bridge work. They may be used, however, when built as portable machines or "mule" travelers, mounted on trucks or flat cars, particularly for the erection of long steel-frame sheds or buildings at industrial plants. This use of stiff-leg derricks at the plant of the Lima Locomotive Co. was described in our issue of May 7. For high steel office and warehouse buildings the preference is for guyed derricks.

AUSTIN TRENCHING MACHINE, OWNED AND OPERATED BY THE CITY OF WORCESTER, MASS.

Editorials

On account of the European War and its consequent effect on American markets, the regular "market prices" supplement to ENGINEERING NEWS, which usually appears in the first issue of each month, has been postponed.

Federal Aid to Road Construction Unlikely

According to a recent Washington dispatch, the Senate Committee on Post Offices and Post Roads, of which Senator Bankhead of Alabama is Chairman, has agreed to report favorably the Federal aid scheme of Ex-Senator Jonathan Bourne, Jr., of Oregon.

Mr. Bourne's scheme was explained and criticised in our issue of May 22, 1913. In general his proposition was to lend the credit of the Federal government to such of the States as desire to borrow money for road construction, the total amount of Federal aid being limited to half a billion dollars. The National government would issue 3% bonds for this amount and would take 4% State bonds for the money it advanced, the difference of 1% forming a sinking fund for the payment of the bonds at maturity.

The chief objection to the Bourne scheme is the objection which attaches to all schemes for building roads with borrowed money; to wit, that the roads to be built will be worn out and gone long before the bonds issued to build them fall due. If the life of bonds issued to pay for road construction or paving were limited to the life of the roads built from the proceeds of the bonds, the objections would be much less serious. But almost invariably states and counties and cities which are building roads and paving streets with borrowed money raise the money by bond issues running twenty-five to fifty years. Part of the colossal debt under which New York City staggers is made up of bonds issued to pave streets on which the pavement already has been renewed two or three times since the bonds were first issued. The present generation of taxpayers is already loaded down with burdens from which they receive no corresponding benefit; they ought not, therefore, to lay increased burdens on the generation which is to follow. For the Federal government to encourage the several States to continue such financial folly would be a crime.

It may be shrewdly suspected that the reason why the Senate Committee has reported this bill of Senator Bourne's is because of its disinclination to report favorably the almost equally foolish House bill for Federal aid to roads, passed some three months ago.

There is considerable reason to believe that both the Senate bill and the House bill were intended rather for political effect than as measures intended for enactment into law, and that neither House or Senate seriously intends to enact any Federal aid to Highways law at this session.

The Water Supply of the Panama Canal

It requires no long memory to recall the dire predictions made only a very few years ago of disaster to the Panama Canal enterprise because, among other things, there was not water supply enough to provide for the traffic. These prophecies of evil were not confined to irresponsible writers for the newspapers. Some learned engineers wrestled with columns of figures and attempted to show that by allowing enough evaporation from the surface of Gatun Lake during the dry season, the level of that body of water would be reduced so low before the end of the season that the traffic would be interfered with.

It is of interest for this reason to compare with these prophecies the results of actual experience. Traffic is not yet passing through the canal, it is true, but during the recent dry season the surfaces of Gatun and Miraflores Lakes have been held at substantially the level they will be when the canal is open. Accurate records of the outflow from Gatun Lake, therefore, enable a close estimate to be made as to what amount of water will actually be available for purposes of lockage.

The *Canal Record* of July 8 summarizes the results of measurements of evaporation and outflow, and the conclusion may be summarized in a single sentence, which we quote as follows:

> The record of the season of 1912, in which the runoff from Gatun Lake watershed was the smallest observed during the past twenty-two years, demonstrates its capacity for all the traffic that can be brought through the canal.

Stating the figures in more detail, the assumption is made that Gatun Lake was at an elevation of 87 ft. above sea level at the beginning of the dry season on Dec. 1, that the hydro-electric plant at the Gatun spillway was continuously operated, and that 48 lockages a day were made. Under these conditions the surface of the lake would be reduced 7½ ft. to 79.5, on May 7, at the close of the dry season. At this elevation the depth of water through Culebra Cut is 39 ft., which is ample for navigation. This average of 48 lockages a day may be compared with the average number of lockages through the Soo Canal on the American side, which was 41.7 per day during the navigation season of 1912. During the eight months of navigation, the Soo Canal in that year passed 14,916 vessels, while the Suez Canal in the same year passed only 5373 vessels. According to these figures, therefore, there is water enough at Panama to handle probably three times as much traffic as now passes via Suez.

The Pittsburgh Sewer Explosion Repeated

A mile length of large trunk sewer blew up in Pittsburgh eight months ago, and since that time a couple of hundred thousand dollars have been spent in rebuilding the wrecked sewer. With this rebuilding work nearly

completed, on July 28 another explosion occurred in the same sewer. Fortunately this time the sewer was not wrecked; yet the explosion deserves to be classed among the violent sewer explosions on record.

Both last November's explosion and the explosion of July 28 appear to have been due to the same cause, namely, gasoline in the sewer. Because the first explosion destroyed such a large part of the sewer there was little chance to determine the cause with any great certainty. Whether for this reason, or not, the city authorities appear to have been a little reluctant about proceeding at once to take stringent measures against the discharge of inflammable wastes into their sewers. Now, after the second explosion, prompt action will undoubtedly be taken and the public will support the authorities in any necessary measures.

The following brief statement of facts of the second explosion is of interest:

The explosion occurred at 9.10 a.m., July 28. Gasoline odor was detected the day before. A quarter-hour before the explosion ten or twelve men working inside of the sewer on repairs were ordered out, as the gasoline fumes became so strong that they could not remain inside. As electric lights were used in the sewer work, it is not clear how the gas became ignited.

The explosion was not serious. Damage was confined principally to breaking of glass in the adjoining mill of the Carnegie Steel Co. The explosion apparently did not extend beyond the length of sewer between the Allegheny Valley R.R. tracks and the sewer outlet. The explosion traveled through the pipe gallery of the steel company opening into the sewer and blew up plates in the mill, also damaging the roof, etc. A few men in the mill were injured by falling glass. The explosion made a loud report, not a muffled one, as in the former case. Working shafts and manholes were open, which probably reduced its force. Flames shot high in the air.

The U. S. Bureau of Mines is working in conjunction with the city authorities in investigating the case, locating sources of inflammable waste, etc.

In furnishing a striking example of the great danger residing in sewer explosions or in the existence of causes which may produce sewer explosions, this second Pittsburgh case is a valuable one. The recurrence of the explosion in the same sewer reinforces the proof by showing that the explosion of last November was not an isolated case, but an occurrence due to a continuously existing cause. It is now the city's duty to find and remove that cause.

A Catastrophe without a Parallel

With almost the suddenness of lightning from a clear sky there has come upon the world during the past week the sudden outbreak of a war involving all the great powers of Europe. Of the vast disaster involved in such a war, it is well nigh impossible to conceive. The whole civilized world is aroused to sympathy and offers of aid when by some cataclysm of nature or some failure of man's work a few hundred or a thousand people lose their lives and a few million dollars' worth of property is destroyed. But the destruction resulting from such a conflict to the death as that which has begun in Europe, may cause, in a very short time, the death of a million men and the destruction of wealth amounting to a billion of dollars.

It is difficult for even the wisest financier or economist or statesman to foresee the results which may follow from this war; but it has already been made evident that even the impending danger of such a war has had far-reaching results in our own country. The universal upsetting of values which swept over every country in Europe within the space of two or three days was felt immediately in our own country, and compelled the closing of every American stock exchange and of many of the exchanges in which other commodities are bought and sold.

Some of the amateur statesmen in our legislatures and even in Congress have been for years agitating against these exchanges, and have sought to close them by process of law. Now that this result is actually brought about by other causes, thousands of business men in all parts of the country find themselves in serious difficulties because of the loss of the facilities which these exchanges afforded.

It has been often and truly said that the United States is probably nearer to absolute economic independence than any other country in the world. When the emergency required, she could close every port, mount a guard on every frontier and absolutely cut off all intercourse with foreign nations. There would be little difficulty, when once the economic adjustment was effected, in supplying all our own requirements, both as to food products and manufactured goods. But nothing short of stern military necessity could compel such an economic readjustment; and the loss and suffering and disaster involved in making it would by itself constitute an overwhelming calamity.

In the year ending June 30 last, government statistics, made public on Aug. 5 by the Department of Commerce, showed that we imported from foreign nations goods to the value of $1,893,000,000, and we sent abroad during that time $2,364,000,000 worth of goods. Over a billion dollars' worth of this was in the form of finished manufactures.

The United States is just harvesting probably the greatest grain crop it has ever secured. The European war will make an enormous market for foodstuffs. It seemed at first that the clash of armies on the plains of Europe meant the opening of a gold mine for a million American farmers, but the eager speculators for a rise on the exchange were suddenly confronted with the problem of how the grain was to be transported and delivered to the warring nations in Europe. With all the great naval powers of Europe engaged in a life and death struggle, any merchant vessel taking wheat to the port of a hostile power would be subject to capture. Doubtless the wheat will go, in some way, for food is as necessary to the armies (which, as the saying is, travel on their stomach) as are guns and ammunition; but the heavy risks involved in its transfer across the ocean and to its final destination may absorb so large a part of the final price that the American wheat grower or wheat dealer may have his expected large profits turned into a loss. This is merely a typical illustration of the dangers and perils and sudden changes which this unprecedented war may bring about. Many thousands will doubtless be made suddenly rich by these lightning changes in the markets and in industry, but many other thousands will as suddenly find themselves facing poverty.

The events of the past week have furnished a marvellous illustration of the extent to which modern commerce and industry is governed by international conditions in economics and in finance.

In the preparation for war during the past week, all the nations of Europe have been grabbing for gold, and not only the nations but the financiers, and not only the financiers but the people. Every French peasant, merchant and manufacturer besieged the banks, seeking to draw his savings in the form of gold, to be carefully hoarded for use in dire necessity. Similar occurrences went on in Germany and even in England. Indeed it is doubtful whether the United States itself could long retain its stock of gold if the doors of international exchange were left open so that Europe could find means to obtain the precious metal. On the other hand, however, there may come a backward flow of gold to this country as soon as the nations abroad, under the stern pinch of necessity, are obliged to have our food products and our manufactures and have nothing to buy them with but gold, because of the stoppage of their own production.

One of the most certain results of a great European war will be a world-wide scarcity of investment capital and a consequent rise in the ruling rate of interest. Indeed such a rise has already taken place, partly as a result of the wars fought during the last dozen years and even more of the preparations for war on an enormous scale which the European nations have made. About the close of the 19th Century, prior to the Boer War in South Africa and the Spanish-American war, the market value of investment funds in the highest-class securities was not far from 3%. During the past year or more the average price has been probably 4 to 4½%. Where the price of capital will go to in the event of a general European war, long continued, can only be conjectured. Such a war would destroy to a large extent the great reservoirs of investment capital in the principal European nations, to which all the rest of the world has resorted for the funds with which to carry on economic and industrial development. It may easily be that a year hence 5% or 6% or even 7% may be the ruling price for investment funds of the highest class. The rate on funds invested in ordinary enterprises, involving more or less risk, such as attaches to almost every private enterprise, must, of course, be correspondingly higher.

The far-reaching results of such a change in the value of capital it is impossible to foresee in full detail. It would have, of course, a vast effect upon the prices of commodities of every sort and of real estate. It will greatly limit the carrying out of works of permanent improvement, in which engineers are so largely concerned, since capital will be difficult to obtain and can only be secured at a high price. It will mean the cancellation of a great number of new enterprises because the reservoirs of capital that were to have sustained them will be dried up.

It can only be hoped that the emergency may bring about new demands for industry and ability to offset those that are cut off. This may indeed be the case. Practically the whole world is dependent on Europe and the United States for its supply of manufactured goods. But from now on the factories of Germany and France and England will be barely equal to the demands made upon them for home consumption, depleted of their labor forces as they will be by the call to arms. In South America, in Africa, in Asia and even in Australia, therefore, manufacturers of the United States will find markets for their products never before opened. A way must be found, of course, to transport these goods across the seas. Doubtless the matter of naval supremacy will be the first to be settled, and if this should result favorably to Great Britain, the British merchant marine will be as available for this work as in the past. We shall doubtless see also a powerful movement to create an American merchant marine, and Congress may revise our navigation laws so that this result may be achieved.

Of especial interest to many engineers is the question what is to be done concerning the half dozen great international engineering congresses which were scheduled for next year.

Besides the great international engineering congress to be held in San Francisco, together with numerous other international congresses relating to many branches of science and industry arranged for there, the International Railway Congress was to assemble next year at Berlin, the International Society for Testing Materials at St. Petersburg, the International Navigation Congress at Stockholm and the Congress of Mining and Metallurgy at London. Doubtless all these congresses will have to be indefinitely postponed. It has been suggested that the American engineers might offer to welcome these various congresses in the United States. But even if it were attempted to hold the meetings here, the attempt could hardly result otherwise than in failure. With the great nations of the world at each other's throats, it is not to be expected that their representatives, many of them government officials, could be brought together in peaceful and friendly conference only a few months hence. Indeed, who is wise enough to foresee the profound changes in nations, in politics, in policies, in races, which may grow out of this terrific conflict? It sounds like a mockery, the circular before us regarding an international exhibition of art and civilization to be held at Dusseldorf next year. But that is only one of several such international events, including our own great exposition at San Francisco, which must be either abandoned or, if held, must do without exhibits from the chief industrial nations of Europe.

It is not our function to discuss the historic causes which have precipitated this catastrophe upon the world nor to portray—what no words can portray—the incalculable suffering and misery which it brings to countless millions.

We may properly, however, point out here that in the opinion of many observers the cause of the war is to be traced not merely to deep social and national prejudice and hatred, but to the vast preparations for war which Europe has made. There is an economic limit to the burdens which a nation can bear. The competitive struggle for superiority in armament had reached the breaking point. The Europe of today has spent more by far on warfare in time of peace than the Europe of Napoleon spent to wage war. The time had come when these vast armies and navies must either be set in motion or reduced, and no nation could reduce its powers of defence without inviting conquest by its rival.

The best that may be hoped from the present terrible conflict is that when it is ended by peace, it may be a peace accompanied by universal disarmament, a peace that shall relieve the nations from those crushing burdens of preparation for war and leave them free to solve those problems of social readjustment which are the pressing problems of this century.

Letters to the Editor

Deterioration of Railway Property

Sir: I am endeavoring to obtain authoritative information relative to the physical deterioration of certain materials used in railway construction, and wish to know if data have ever been compiled that will show the ratio of deterioration of ballast, rails, ties, bridges, etc., due entirely to weather conditions, as against deterioration due entirely to wear from traffic.

For instance, it has been arbitrarily assumed that ties deteriorate 75% on account of weather conditions and 25% on account of traffic, and that ballast is deteriorated 90% by weather and 10% by traffic.

If you can refer me to any authorities or to publications treating with the above as I have outlined it, it will be much appreciated.

R. W. Le Baron,
Engineer Examiner of Joint Facilities, Chicago Great Western Ry.
Chicago, July 3, 1914.

[Probably these matters have been investigated by the railway and government valuation engineers, and we shall be glad to receive information for the benefit of our readers.—Editor.]

Highway Location in Mountainous Country

Sir—The recent good-roads crusade has marked an epoch in road building, and has been responsible for a heavier and more costly type of road construction than is really necessary or justifiable.

When state governments commenced spending millions on roads, the old "compass chaser" and "prairie schooner" passed into the limbo of a bygone day. The railroad locating engineer was called in to survey the trail for automobile and motor-truck traffic.

There is no question but that a railroad engineer was of all men best adapted for this work; but in approaching the new task, far too many of the old ideas clung to him and refused to be shaken off. The most persistent idea was the one that dealt with the grade line—the old locator would look at his Plate "A" profile paper and draw on his grades from 2000 to 5000 ft. long; the idea of breaking grade every 300 to 500 ft. if necessary, he felt to be a sacrilegious act on the part of one who had sat at the feet of Wellington.

The heavy freighting of the west was done over roads that had miles of 10% and 15% grades. One would not say these were desirable, but they were the best the country afforded at a reasonable cost.

State roads are being built over mountain ranges in the West where the distance development is excessive, and where the maintenance cost will always be a constant tax on the road, solely to appease the worshippers of the 5% maximum grade fetish. To do this, they are willing to loop the loop, build figure S's and design a road looking like a Moorish maze—in other words they go all around Riley's barn to get to the door.

At least 90% of the future traffic on these roads will be by power-driven vehicles, where distance is a greater factor than grade. It would be better in mountainous country to build 2 or 3 miles of 8% grade to cut out one mile of distance.

Action and re-action; it is the same old story; from having roads with 20% we have gone to the other extreme of 5%. No engineer in the State of Washington will be able to use his judgment on the matter for a state law has been passed to tie him down to 5%. In rough and rolling country one should never hesitate to break grade to keep down construction costs, taking care that the drainage is being cared for as well.

Highway location is still in its infancy, a few more railroad ideas will have to be almost forgotten. There is as much difference between a road and a railroad, as there is between an oak and cherry tree.

An 8% grade is low enough for a maximum grade in the mountains or very rough hilly country, and will result in a better road in every respect. It is, of course, presumed that the locator will only use a higher rate of grade when necessary, and only after a careful trial of a lower rate.

Regarding curvature—anything up to a 40° curve is allowable on mountain work. Curves of 20° and upward can be used in any place, where the P. C. and P. T. are in sight along the long chord of the curve.

This letter is only a plea to be allowed to use a higher rate of grade where it is shown to be necessary, especially in cutting out loops and long winding developments on mountain roads. The saving in distance, surfacing and maintaining the same, besides eliminating dangerous curves will more than repay its use.

F. W. Harris,
Engineer, Washington State Highway Commission
Renton, Wash., June 6, 1914.

Following the Crowd in the Valuation of Public Utilities

Sir—It is becoming less and less the privilege of modern city dwellers to see a flock of sheep in their natural habitat, but the pastoral game of "follow the leader" is ever new. Aside from inventions and their application, there is but little really new in the principles of true engineering. However, even eminent engineers, as well as jurists, continue to enunciate "principles," "axioms," "corollaries," "precepts," "rules," "opinions," etc., concerning the valuation of public utilities, as if there was something radically new about it, and others, anxious to keep in the procession, immediately rush into the field, with antics similar to those of their four-footed friends before mentioned.

As a matter of fact, scarcely have there been two im-

portant cases, so alike in conditions, that any one set of rules would equally apply. The writer has no desire to criticize or condemn such rules as have been put forward, or to offer substitutes therefor, but rather to call attention to the foolishness of following any sets of rules or precepts or court declarations, without first giving a very thorough study and analysis to the particular case that may be under consideration.

From the earliest eras of man, transfers of the ownership of property and rights have taken place, either solely through direct negotiation between the parties interested, or with the aid of friends called in to depreciate or bolster up the respective ideas of value; in more difficult cases, there has been resort to supposedly impartial judges. Now what more is it today? Nothing—except that in the sharper business competition of the present, perhaps greater general injustice prevails, with less regard for personal rights and consequently more frequent recourse to impartial tribunals.

As against some greater disregard for personal rights, there is a growing public view that corporate rights, as represented by real investment in public utilities, must be protected and the actual investor of money and brains, be guarded against too great a Socialistic sentiment; hence the multitude of legal proceedings to establish rates and values. These result in great masses of testimony, too rarely well digested, concerning original cost, cost of reproduction, going value, depreciation, earning value, reasonable profit, etc. Almost without exception, however, in the cases noted in very recent years, local circumstances have very properly had a strong influence in final determinations.

A privately owned public utility may be the chief means of developing a community, yet that fact may not be reflected to large extent, in the costs of construction or operation, or in its business profits at time of proposed public acquisition, while the future might hold promise of an ultimately profitable investment. No ordinary rules of acquisition would provide for such a return as the owners should justly receive to compensate them for actual, even though intangible, results of their forethought, investment and energy; in fact, most rules as laid down would virtually penalize the owners for having entrusted their capital to works so slow in returning hoped-for profits.

All such problems need to be approached with absolutely unbiased minds and without preadopted notions of the procedure to follow. Any intelligent engineer, familiar with costs of construction, expenses of operation, actual depreciation, and the conditions attending development and carrying on of similar business, can begin to attack the problem. He must then carefully study the physical and financial history of the enterprise, the local circumstances attending inception of the project, the community attitude and response and the probable future outlook, and he must pay some attention to the business intelligence exhibited by the management in handling its trust.

If financial markets have handled the utilities securities in an active manner, one criterion of value can be set up, but not by any means a binding one, without other verification. One utility, under the writer's notice, depended for much of its value on what might be done in the future through the use of powerful influences and business acumen, rather than on earning value at the time of investigation, for its immediate sales market had been virtually lost for the time being. Yet the utility represented millions actually invested, and upon which there might well be abundant later return.

What rule or principle as yet laid down would establish a fair value in such a case? None!

Valuations are for three main purposes: (1) to secure for a community the control of a privately owned utility at a price reasonable to the public and just to the owner; (2) to secure for the public, rates for service rendered, that shall be as low as possible, yet yield a fair business return upon the capital invested and brains used for management; (3) to establish a value upon which just taxes shall be levied.

To some extent, if the "signs of the times" do not change their indication of strong Socialistic tendencies, similar policies will soon obtain, concerning other private enterprises that deal with commodities which have become necessities for public use. Discussion of that division of the subject, however, is not pertinent here.

The formulation of valuation rules is educational; the more that appraisal problems are studied, analyzed and described in detail, the better for law and engineering, and the better for clients. But beware of being sheep.

The foregoing little lay sermon was inspired by some late valuation articles, reports, and decisions with which I have been edified. The complacency of their authors, has been the immediate cause of jotting down the above comments. If they find appropriate place in ENGINEERING NEWS, I hope they may not be without service.

LOUIS L. TRIBUS.
Tribus & Massa, 86 Warren St., New York City.
July 16, 1914.

Design of Crane Runway Girders

Sir—In the interesting account of the new shops for the Lima Locomotive Corporation, given on p. 1002 of your issue of May 7, I notice that an 80-lb. crane rail on an inverted 15-in. channel is described as "resting" on the top flange of the runway girder. I should much appreciate further particulars of the attachment of this channel to the top flange, as from theoretical considerations the more rigid it is the less economical is the combination for resisting the horizontal side thrust.

This paradox can be explained as follows: If the channel is designed to take side thrust and is not made part of the runway girder designed to take the vertical load, the extra stress in the channel, due to the vertical load, will be very small, as the total vertical load will be carried by the channel and girder, each taking an amount directly proportional to its moment of inertia.

If the channel is securely riveted to the top flange, the vertical load will cause it to be more highly stressed than any part of the top flange, so that less side thrust than before is needed to stress it to its maximum allowable limit unless the girder itself is very strong sideways.

The strength relations of the channel and girder may be expressed mathematically as follows: Let

B_h = Horizontal bending moment;

B_v = Vertical bending moment;

M_h = Horizontal section modulus of the channel;

M_v = Vertical section modulus of the girder;
f = Allowable stress in each.

If both channel and girder are designed just strong enough to deal with the horizontal and vertical loads, respectively,

$$f = \frac{B_h}{M_h} = \frac{B_v}{M_v}$$

If they are riveted together, let

$M_h(1+a)$ = New effective section modulus resisting horizontal bending;
$M_v(1+b)$ = New effective section modulus resisting vertical bending.

Then, if the combination is still adequate

$$f = \frac{B_h}{M_h(1+a)} + \frac{B_v}{M_v(1+b)}$$

That is,

$$f = \frac{B_h}{M_h} - \frac{a}{1+a}\frac{B_h}{M_h} + \frac{1}{1+b}\frac{B_v}{M_v}$$

but

$$f = \frac{B_h}{M_h} = \frac{B_v}{M_v}$$

$$\therefore \frac{a}{1+a} = \frac{1}{1+b} \therefore ab = 1$$

That is, if the channel increases the strength of the girder by one-third, the girder must increase the strength of the channel by 300%, a highly improbable contingency.

WM. A. GREEN, A. M. Inst. C. E.,
Asst. Engineer, R. A. Skelton & Co.
London, England.

[We referred the above letter to the Worden-Allen Co., of Chicago, which designed and built the shops in question, and have the following reply—ED.].

Sir—Relative to the crane-runway girders in the locomotive shop of the Lima Locomotive Corporation, the undersigned is unable to recollect the exact method of fastening the channel to the top flange angle of girders. There were, however, sufficient rivets connecting the channel to the flange angles so that this channel is part of the girder.

Using the same notations as in the above discussion, the equation $F = \frac{B_v}{B_m}$ does not state the exact condition. The moving load passing over the girder will produce a certain deflection, but the stiffness of the channel about a plane parallel to its web being negligible it will deflect the same amount as the girder, producing a stress from the vertical load in addition to a stress from the bending moment from the assumed side thrust. This shows that it is impossible to design a girder which will take care of the side thrust independently of the vertical load.

Were it possible to obtain the above conditions, however, the result of the calculation based upon the assumption that the channel is part of the top flange does show that the increment by which the section modulus of the girder in the vertical plane is increased is equal to the increment by which the section modulus of the top flange in the horizontal plane is increased, a result that cannot be true, considering the respective sections and their respective lever arms.

Furthermore, it is questionable if the term $\frac{B_v}{M_v}$ in the calculation dealing with the channel and girder separately is equal to the term $\frac{B_v}{M_v}$ in the calculation dealing with the channel being part of the girder. Considering the channel as part of the girder, the center of gravity will rise up toward the top a certain amount, giving a different section modulus. For this reason it is the opinion of the undersigned that the terms and questions are not equal and hence cannot be interposed from one equation to the other.

It is true that the channel, considered as part of the girder, will increase the girder strength. How much it will increase it, however, has to be determined in each individual case. The above discussion shows the fallacy of the conclusion reached that if the channel increases the strength of the girder by one-third, the girder increases the strength of the channel by 300%.

FREDERICK HOFFMAN,
Engineer, Worden-Allen Co.
Commercial National Bank Bldg., Chicago,
July 21, 1914.

NOTES AND QUERIES

The inquiry in this column some weeks ago in regard to the construction of reinforced-concrete cooling ponds has been answered satisfactorily by several engineers. We hope to have a description of one or more such tanks in an early issue.

A Wind-Wrecked Gantry Crane, Marion, N. J.

The wreck of the 150-ton gantry crane at the Marion Generating Station of the Public Service Electric Co., of New Jersey, noted in our issue of last week, is very

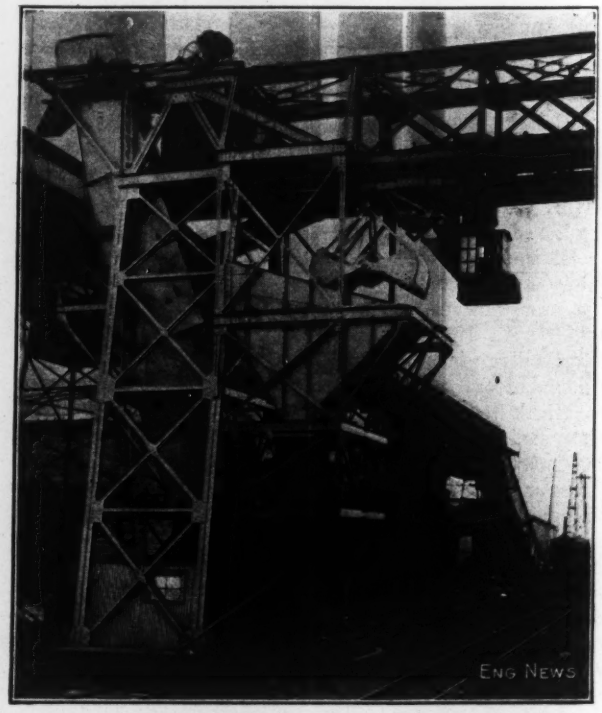


FIG. 1. ONE END OF CRANE BEFORE ACCIDENT

FIG. 2. GENERAL VIEW OF OVERTURNED CRANE

interestingly shown in the accompanying views. The span of the crane was 150 ft. 2¼ in., 43 ft. 1 in. high to upper chord, with wheel bases 27 ft. long. The principal operating features of the crane are shown in Fig. 1 of the tower nearer the station.

The cross structure of the crane carries a belt, which can be supplied with coal from the belt conveyor running parallel with the station. The coal is conveyed on the crane belt to about the center where it is tipped, falling to storage piles. When it is desired to return the coal from the piles to the station, the clam-shell bucket places the coal into the hopper over which it is suspended (Fig. 1). After being crushed it is carried up to the belt on the stationary structure, running parallel to the travel of the crane. The track on which the crane travels is 300 ft. long and is not provided with bumpers at the end.

A high wind on July 23 carried the crane from one end of its track to the other at rapid speed. When it reached the end of the track the forward trucks went off onto the ground, a distance of about 8 ft., where they sank. The crane, of course, fell over in the direction of its motion, not only wrecking itself but also a yard locomotive. The position of the crane after its fall is shown in Fig. 2. Fig. 3 shows the wreckage of the crane and the locomotive. The small views at the right of Fig. 3 show the manner in which the forward wheels sank into the ground after derailment. The bearing cap of one is shown to be broken, leaving the wheel nearly buried.

The crane is damaged beyond repair and it is expected that a new one will be erected in its place. The damage is estimated at $50,000. The crane was furnished ten years ago by the Robins Conveying Belt Co., New York City. It was braked by a locking device on a reduction shaft from the driving motor. It is claimed by the electric company that all driving wheels were locked in this manner at the time of the accident.

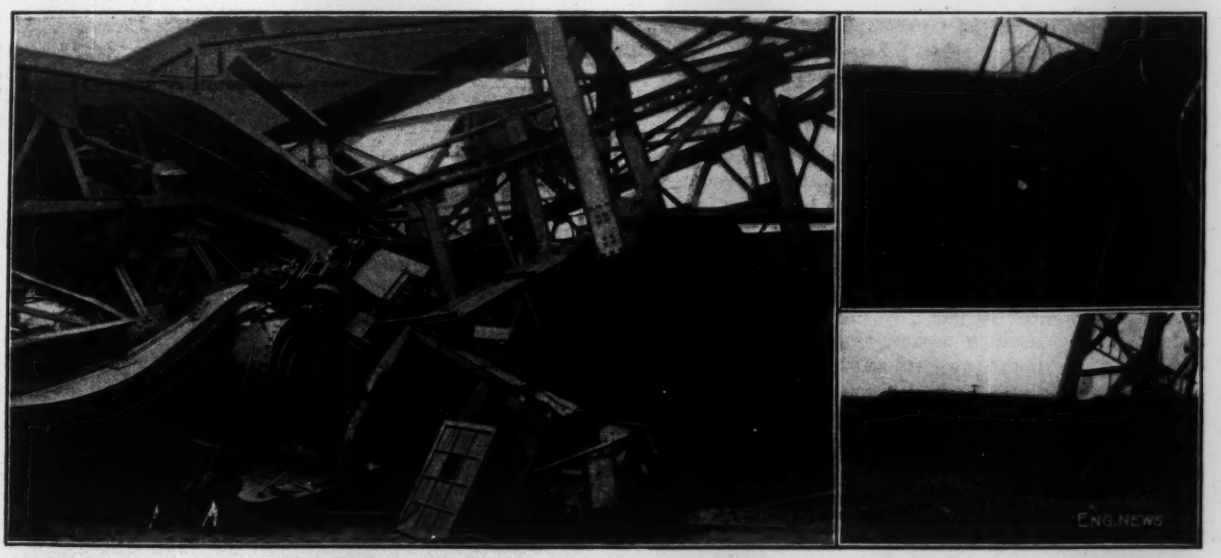


FIG. 3. (LEFT) POSITION OF YARD LOCOMOTIVE BENEATH WRECK. (RIGHT) DETAILS OF DERAILMENT

(The structural excellence of a locomotive boiler is exhibited in a remarkable manner in the left-hand view.)

Noteworthy Concrete Structures on the Lake Erie & Eastern R.R.

The Lake Erie & Eastern, a six-mile extension of the Pittsburgh & Lake Erie Ry. through the city of Youngstown, O., is a high-level line and includes a large number of bridges and viaducts, some steel and some concrete. Noteworthy innovations in design and construction are found in these structures, as will be seen from the following notes on the concrete structures. The steel structures will be reviewed in a later article.

FIG. 1. SKETCH MAP OF LAKE ERIE & EASTERN RY.

A location sketch (Fig. 1) of the Lake Erie & Eastern shows the three river crossings and the adjacent viaducts.

The line departs from the four-track P. & L. E. line at Struthers (a few miles south of Youngstown), crosses the Mahoning River to the right bank, and ascends on embankment and hillside cut until, opposite the center of Youngstown, it enters on a one-mile stretch of embankment, street-crossing and viaduct construction up to the second bridge over the Mahoning near the city filter plant (Crossing No. 1, in Fig. 1). Thence it cuts through high ground for one-half mile and crosses the river a third time, swinging back to the right bank along the Ohio Works of the Carnegie Steel Co.; here a 1500-ft. length of the embankment is made of poured slag, retained along the river bank by a wall laid up of enormous cast-slag blocks. Beyond this fill the line crosses the river the fourth (and last) time, and a few hundred feet beyond it crosses over seven railway tracks (Erie, Baltimore & Ohio, Pennsylvania and joint) on a long skew, by means of a long-wall structure decked with I-beams bedded in concrete. About a quarter mile farther on is a similar crossing, but over only five tracks and not quite so sharply skewed. The present work terminates with this structure, leaving the line 30 ft. above ground.

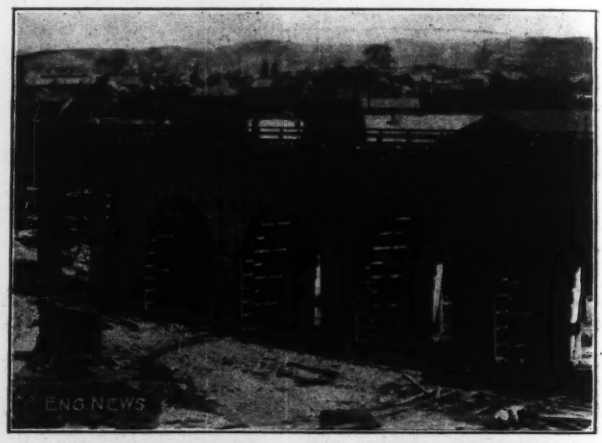
The location west of this point is not finally decided; it will lead to a connection with the Pennsylvania Co. at Girard or to another point near Niles Junction.

The line is very costly. Some of the work quantities are: Grading 942,000 cu.yd.; concrete masonry 110,400 cu.yd.; steelwork, 12,800 tons.

The four river bridges are steel truss and plate-girder structures. Some approach viaduct, the railway crossings, and all street bridges over the railway, are also steel, on concrete piers or walls. The street undercrossings are all concrete arches, however, and whenever viaduct construction was required by right-of-way limitations concrete viaducts were built, except that [illegible] river flats near the filter plant steel viaduct on co[illegible]te piers was used in harmony with city water-wor[illegible] quirements.

ARCH-WALL CONCRETE VIADUCT

The concrete viaduct (Figs. 2 and 3 show one po[illegible]) is an original and ingenious type of structure. It con-sists of two longitudinal walls interrupted by arched openings at intervals of 32 ft., which break up the lower part of the wall into piers 9½ ft. long. At each such pier a cross-wall connects and braces the two longitudinal walls, but this cross-wall carries no vertical load other than its own weight. Across the main walls is laid a deck of 15-in. I-beams spaced 18 in. apart c. to c., and these are surrounded by and bedded in a 19½



FIGS. 2 AND 3. ARCH-WALL VIADUCT ON LAKE ERIE & EASTERN RY., NEAR CROSSING OF THE B. & O. R.R., YOUNGSTOWN, OHIO

in. thickness of concrete, which carries a normal ballast-and-tie railway track.

The drawing Fig. 4 shows a typical portion of this viaduct. Dotted lines indicate the horizontal construction joint in the longitudinal walls, by which the walls are divided into (1) piers with curving overhang portions on either side, and (2) a longitudinal girder over these piers, shaped so as to complete the curve of the pier overhang and form a semicircular arch top of the opening between piers. The openings do not represent the structural character of the wall, however; the action is purely that of piers and girders.

In the view Fig. 5 some of the forms for the arch-walls and cross-walls can be seen.

Where the viaduct joins an embankment, the end cross-wall is made very thick—30 in.—and forms a reinforced slab diaphragm between the longitudinal walls to take the earth pressure. There are no wings, however, the earth being allowed to slope down around the concrete structure on its natural slope. Where the viaduct is so high that the toe of the slope may reach the second cross-wall, this (in its lower portion only) is also built heavy to resist earth pressure.

The walls have vertical bars projecting from the top, which bond into the concrete filling of the deck.

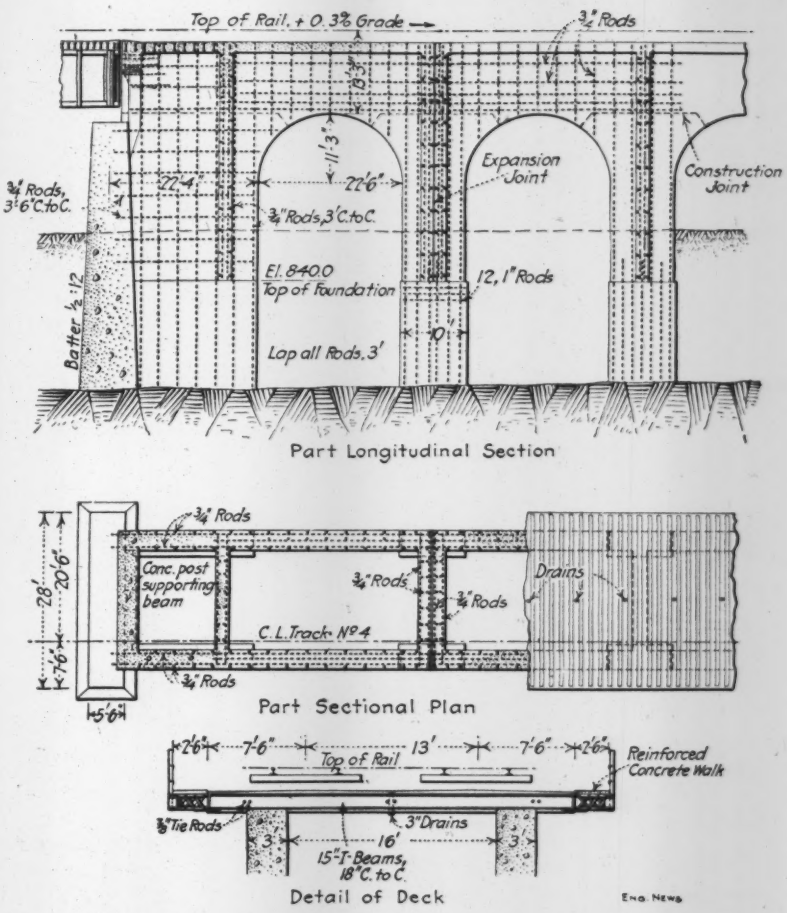


FIG. 4. ARCH-WALL VIADUCT ON LAKE ERIE & EASTERN

SPECIAL CONCRETE-PILE FOUNDATIONS

Concrete piles of a new type are employed as foundation for a considerable length of this concrete viaduct, and also some other viaduct and bridge piers of the line. These piles, described in a recent issue of ENGINEERING NEWS (June 25, 1914, p. 1412), consist of premolded reinforced-concrete inserts set into a hole made by driving a steel casing into the ground, and are grouted into the hole while the casing is pulled. Besides the novelty of the piles, a remarkable feature of these foundations is the high pile-load, 50 tons working load per pile with impact, or about 40 tons without impact.

FIG. 5. FORMWORK FOR ARCH-WALL VIADUCT, LAKE ERIE & EASTERN

The piles are 16 in. in diameter, by about 20 ft. long. Test loads of 60 tons produced no permanent settlement that could be measured.

CONCRETE SKEW ARCHES

The most important of the six concrete arch street-crossings is at Mahoning Ave., Youngstown, with a span of 64 ft. square, or 85½ ft. measured on the skew. The length of barrel, 82 ft. 10 in., is divided into four rings by construction joints parallel to the arch faces, so that the rings necessarily act as skew arches. The drawing Fig. 6 shows this arch.

A skewback construction joint (not shown) was made to stepped outline, with faces of the steps normal to the arch pressure-line. The forms for the abutments were cut to the appropriate stepped outline at the top, and the concrete screeded off, to produce this stepped joint.

These arches are founded on the soil direct, a good gravel stratum being available for a footing some 7 ft. below the surface.

The end faces of the arch, and the showing faces of the wings, were rubbed after removal of forms. The inside of the arch barrel was left as it came from the forms; while it shows the joints of the lagging,

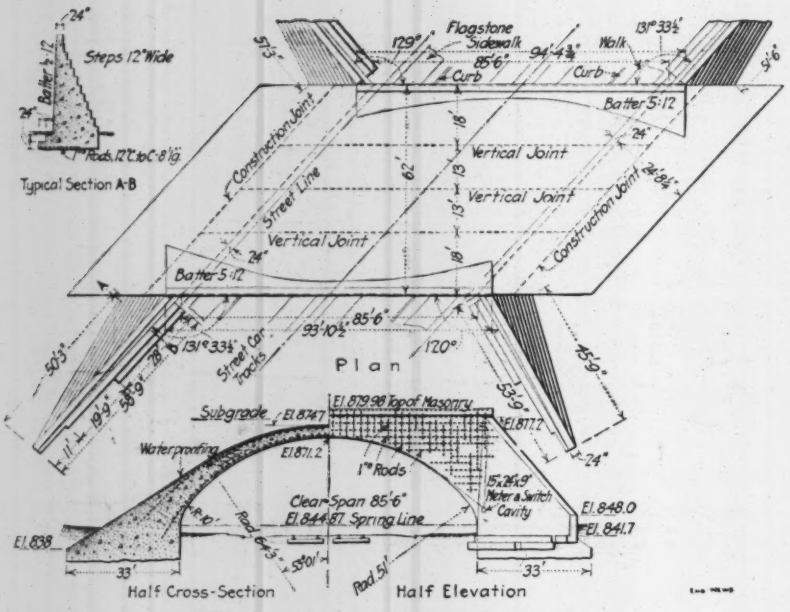


FIG. 6. HEAVY CONCRETE SKEW ARCH, MAHONING AVE. CROSSING OF THE L. E. & E. RY., YOUNGSTOWN, OHIO

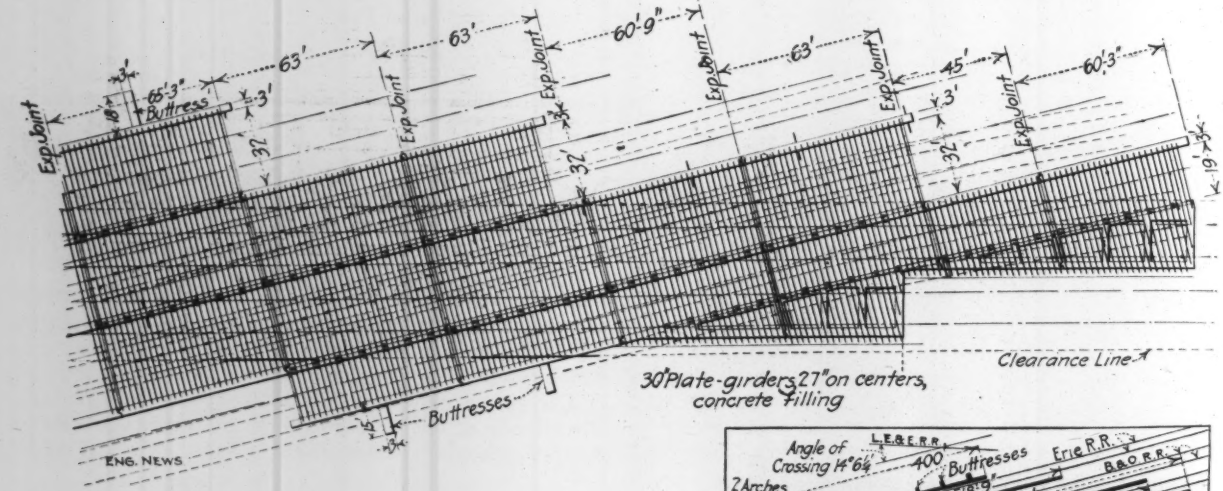
the surface is satisfactorily [illegible].

WALL-AND-BEAM CROSSINGS OF RAILWAY TRACKS

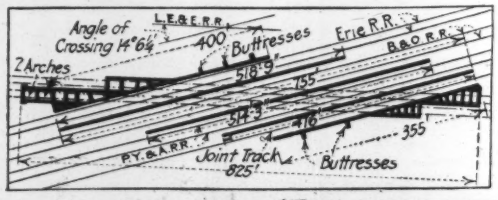
The long skewed 5-track and 7-track railway crossings (Fig. 7) are composed of a deck of transverse plate-girders, closely spaced, carried on longitudinal walls between alternate pairs of tracks. The walls are offset past each other successively, corresponding to the stepped outline of the beam deck (as seen in plan).

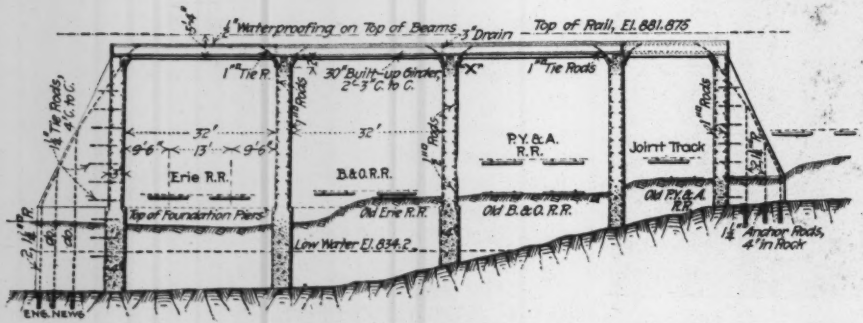
The longest of these walls is over 500 ft. in length. The height above ground is 25 ft., and the greatest depth of foundation below ground is 22 ft. The walls go down to rock, but where the depth to rock exceeds 12 ft. the part below ground consists of individual piers 12 ft. long and 12 ft. apart in the clear, the continuous wall beginning just below ground line.

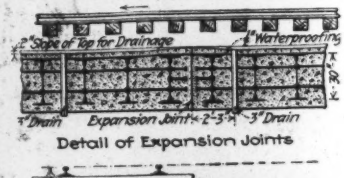
The walls contain both longitudinal



PLAN OF NORTH HALF OF CROSSING







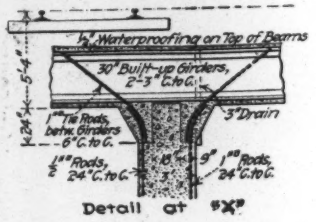
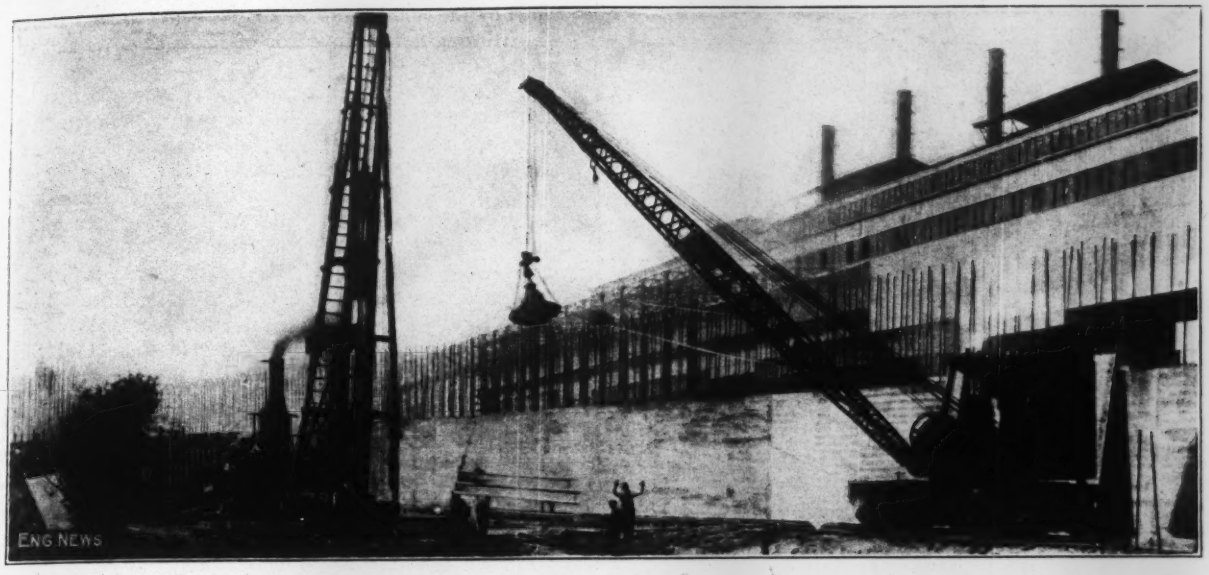

½" Waterproofing on Top of Beams
30" Built-up Girders, 2'-3" C. to C.
3" Drain
1" Tie Rods, betw. Girders 6' C. to C.
1" Rods, 24" C. to C.
9" 1" Rods, 24" C. to C.
Detail at "X"

FIG. 7. WALL AND GIRDER CROSSING OF L. E. & E. RY. OVER SEVEN RAILWAY TRACKS AT BRIER HILL STEEL WORKS



FIGS. 8 AND 9. CROSSING OF LAKE ERIE & EASTERN RY. OVER SEVEN RAILWAY TRACKS, DURING CONSTRUCTION

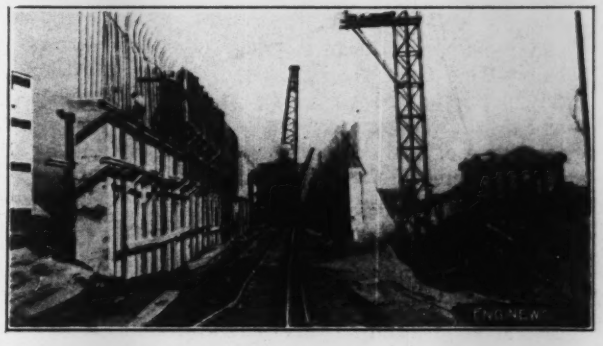
and vertical reinforcement. They were made in construction sections 45 to 65 ft. long, all steel being interrupted at the joint, for expansion and contraction.

Concreting was done in large part by tower and chute, one set-up being sufficient to cover about 80% of the crossing. The larger of the two crossings, built by the Duquesne Contracting Co., is so spread out that although concrete was chuted over 300 ft. the farther wall could not all be reached in this way. For this portion, the concrete was delivered by the chutes to buckets at ground level, and these hoisted by locomotive crane and dumped into the forms. The other crossing, built by the McKelvy-Hine Co., did not require this expedient.

WARPED-SURFACE RETAINING-WALLS

Some uncommon retaining-walls occur at different points of the line. The walls are all of gravity section, but in a few cases they were built with a base capable of carrying an increased height of wall, for later changes in track arrangement. In such places the wall is in shape the bottom portion of a full-height wall, and the top width is therefore abnormal. No steel bond is provided for the future upper section.

A more special form of wall was used at the southeast abutment wing of the third Mahoning River bridge, making a transition from the normal 1:12 batter of the bridge abutment to the 1:4 batter of the slag river-wall. This wall, Fig. 10, has warped surface both front and back, the back batter changing on account of change in elevation of footing. But the face is not a simple warped surface. At one end the profile of the wall shows an upper vertical portion and below this a 1:12 battered portion; at the other end the batter is continuous 1:4 from top of wall to footing. The face thus consists (in theory) of two warped surfaces tangent at one end of their intersection; in actual construction the shape was produced by bending the lagging to the profile frames, and probably varies from the theoretical surface form.



Less complex warped surfaces occur at other retaining-walls. But most of the walls have stepped back, to take advantage of the weight of the earth backing.

MATERIALS

Slag is used extensively on the Lake Erie & Eastern. Besides its use in poured and block-cast embankment construction, it is used for all sub-ballasting, this being granulated slag.

However, no slag was used in the concrete. Other concrete work in Youngstown frequently employs crushed slag for sand and coarse aggregate—granulated slag is unsuitable—and good results are reported. The railway work however was all built with Pittsburgh sand and gravel from the Ohio River.

ENGINEERS AND CONTRACTORS

The construction work, under J. A. Atwood, Chief Engineer, and A. R. Raymer, Assistant Chief Engineer of the Pittsburgh & Lake Erie Ry., was directed by F. J. Mannah, Assistant Engineer (succeeding E. F. Wendt), with R. T. McMaster in local charge as Resident Engineer. All designs were prepared in the office of A. R. Raymer. Albert Lucius, New York, is the Designing and Consulting Engineer for all steelwork.

The work was divided into three line contracts. The southerly part, which is largely rock excavation and embankment, was carried out by H. A. & R. L. Culbertson. The middle section, of rock excavation and embankment,

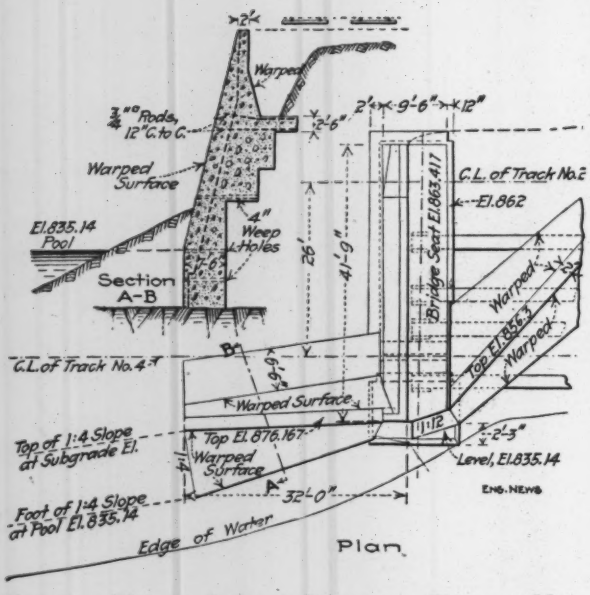


FIG. 10. WARPED-SURFACE RETAINING-WALL AT MAHONING RIVER CROSSING NO. 3, L. E. & E. RY.

and the upper railway crossing, were done by the McKelvy-Hine Co. The concrete structures of the northerly part, and the earth excavation between the second and third river bridges, were done by the Duquesne Contracting Co. The McClintic-Marshall Construction Co. built and erected the steelwork, including the I-beam and plate-girder decking. The concrete filling of the deck is being done by the McKelvy-Hine Co.

All structures are now complete except the lower river bridge (at Struthers) and the concrete filling of the viaduct deck. Embankment has still to be finished at several points, and an earth cut widened as it was taken out only wide enough for a construction track because the material could not be moved to the points where fill was needed until completion of the line.

High-grade track, with screw spikes and four-hole tie-plates carrying 100-lb. rail, is to be used on the line.

The Official Opening of the Cape Cod Canal

After five years of continuous construction work the famous Cape Cod Canal, between Buzzards Bay and Cape Cod Bay on the coast of Massachusetts, was formally opened for the traffic of vessels of 15-ft. draft on Wednesday, July 29. The projected depth of the canal is 25 ft., but its opening for vessels drawing 15 ft. was an event of no small historical significance, since the canal project is about as old as the State of Massachusetts. Its construction was begun and abandoned so many times, and the date set for its final completion changed so frequently, that the Cape Cod natives long ago despaired of witnessing so notable an event as the passing of an excursion steamer carrying several hundred passengers.

The official opening was first announced to take place on July 4, but the ceremony on that date had to be revised to the rowing of a boat part way across the waterway by August Belmont, the New York capitalist, who is President of Cape Cod Construction Co. The ceremonies of July 29 were more elaborate. A special train was provided by the canal company from Boston to New Bedford, which brought the Governor of Massachusetts and other notable guests.

At New Bedford, all invited guests were taken on board the "Rose Standish," a Boston excursion steamer, and under an escort of seven United States torpedo-boat destroyers, several private yachts, tugs and other craft, the "Rose Standish" proceeded to the head of Buzzards Bay, the western entrance to the canal. After reaching the entrance to the five-mile channel, which forms the western section of the canal, the naval escort, with the exception of one torpedo-boat destroyer, returned to Buzzards Bay. The official fleet then passed through the canal from west to east, arriving in Cape Cod Bay in about one hour and a half.

About all the native and summer residents of the Cape appeared to have congregated on the banks to welcome the passage of the fleet and the enthusiasm was quite infectious. On arriving in Cape Cod Bay, the fleet was turned about and returned through the canal to the Buzzards Bay entrance, where the party was landed and speeches were made by Governor Walsh, of Massachusetts, August Belmont, of New York City, and others.

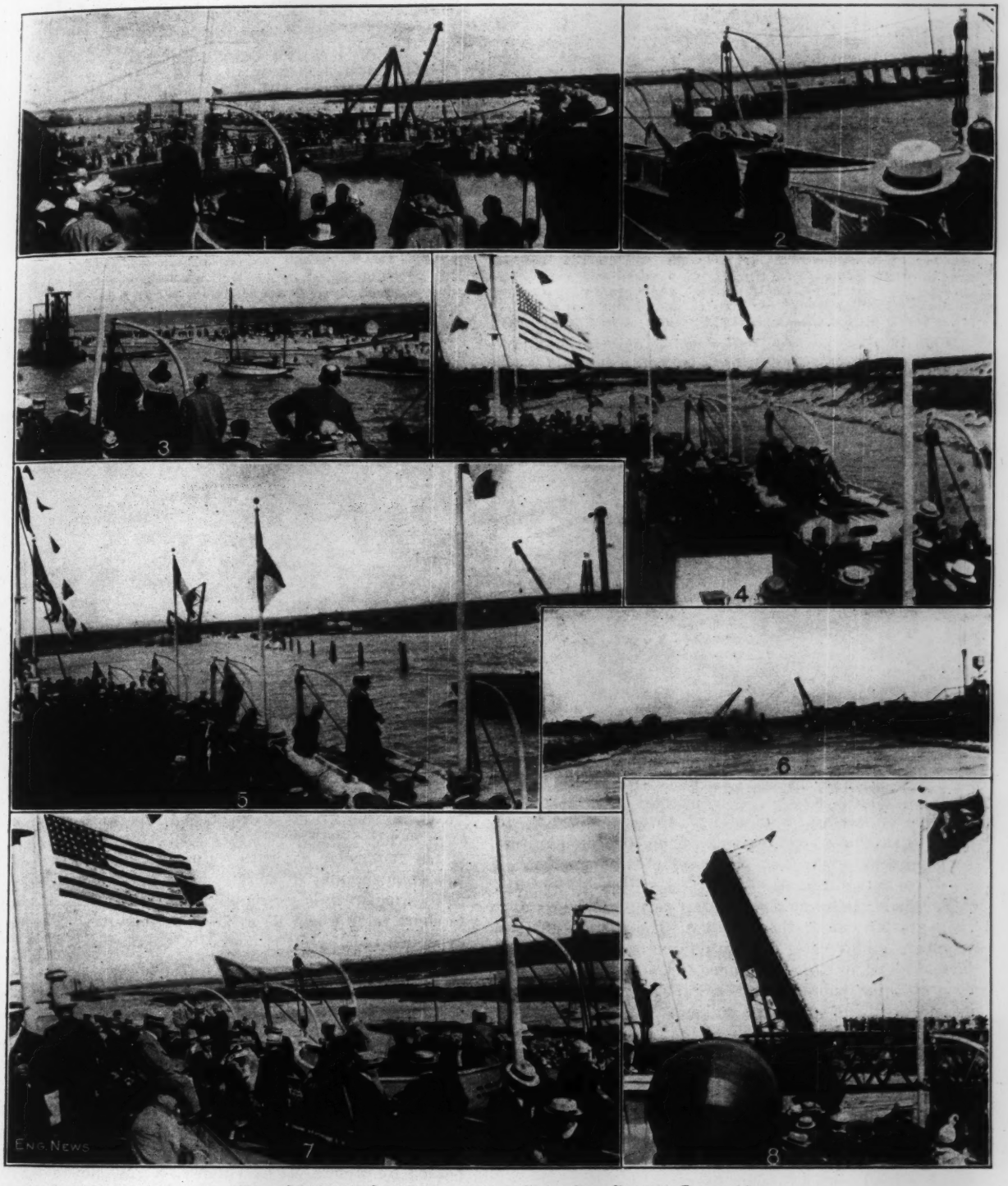
Work on the canal was begun by the Cape Cod Construction Co. on June 19, 1909, by placing the first stone on the 3000-ft. breakwater at the eastern entrance on Cape Cod Bay. Most of the excavation was done by dredges working in from both ends. About 800,000 cu. yd. in the central section were removed by steam shovels. By building dams across the channel at each end of the section these shovels were kept at work until the excavation was 15 ft. below sea level.*

The maximum difference in sea level at the two ends of the canal, due to difference in tides in the two bays, amounts to about 8 ft. The current due to this difference was estimated at about 4 mi. per hr., but from all appearances this velocity is greatly exceeded in the present 15-ft. channel. It is evident that all the problems of operation and maintenance are not yet solved; and it may be found necessary to add a tide lock, which was a part of all the early plans for the canal. The swift currents at times of spring and neap tides, like that of July 29, are sure to cause difficulty in navigating barge tows through so narrow a channel (100 ft. at the bottom), as well as the problem of caring for the silt that the swift current is surely going to deposit in the Buzzards Bay approach channel.

The canal is to be operated as a commercial enterprise. Tolls range from $4 for a canoe or row boat up, according to recent press reports.

The engineering staff of the Cape Cod Construction Co. consists of William Barclay Parsons, Chief Engineer; Eugene Klapp, Deputy Chief Engineer; Charles T. Waring, Resident Engineer; and A. S. Ackerman, Senior Assistant Engineer. The contractors were, the Degnon Contracting Co., the Furst-Clark Construction Co., C. W. Reynolds, the E. W. Foley Construction Co., the Pennsylvania Steel Co., the T. A. Scott Co., the Wilson & English Construction Co., and the Holbrook, Cabot & Rollins Corporation.

*A full account of the construction methods on the Cape Cod Canal was given in "Engineering News," Feb. 19, 1914; a historical sketch of the enterprise and a description of the topographical features of the country were given in "Engineering News," Jan. 9, 1913.



THE OFFICIAL OPENING OF THE CAPE COD CANAL, JULY 29

(1) On board the "Rose Standish"; the Sandwich (eastern end of the canal.
(2) Torpedo-boat destroyer escort, one of which passed through the canal.
(3) Looking to the east across Cape Cod Bay.
(4) Curved section west of Sagamore.
(5) Buzzards Bay entrance to canal and railway drawbridge.
(6) Highway drawbridge at Sagamore.
(7) Sandwich marshes.
(8) Highway drawbridge at Buzzards Bay.

Bridge and Ferry Building by Engineer Corps of Austrian Army*

The accompanying view shows a detachment of the Austrian Engineer corps engaged in erecting a temporary bridge. Austria maintains no mounted engineers. A unit of three wagons are assigned to each cavalry regiment of 900 sabers. Three classes of bridges can be built with the material in these wagons:

(a) NORMAL BRIDGE—Whole pontoon supports, four balks per bay, three-panel roadway, suitable for the passage of all arms accompanying a cavalry division. Maximum length, 60 ft.; width, 7 ft. 10 in.; 15-ft. bays.

(b) HORSE BRIDGE—Whole pontoon supports, three balks per bay, two-panel roadway, suitable for cavalry in file. Length, 90 ft.; width, 5 ft. 4 in.; 15-ft. bays.

(c) FOOTBRIDGE—Half pontoon supports, two balks per bay, one-panel roadway, for men on foot only, horses swimming below bridge. Length, 162 ft.; width, 2 ft. 7 in.

None of these bridges is very strong. With the normal bridge (the strongest) field guns must be unhitched and moved across by hand. The lighter bridges require that the troops separate from the ammunition, baggage and provisions. Hence the most practical of the three is the normal.

For the crossing of streams, ferryboats are relied upon to a greater extent than bridges. Each unit of three wagons contains parts for two landing stages and a rope ferry of two or three pontoons. The usual ferry consists of three pontoons lashed gunwale to gunwale and decked over. It will carry either:

Six horses and riders;
Two guns and limbers, without horses;
Two field wagons and 25 men;
Fifty-five armed men;
Sixty-six unarmed men.

The passage of a cavalry division across a stream of average size requires from one to two days, depending whether the horses are swum over.

The pontoons are built with steel frames covered with galvanized sheet steel. The bottom is covered by a flooring of three fir planks. They draw, light, about 1½ in., and are thus described:

Length	16 ft.
Beam	4 ft.
Depth	2 ft.
Thickness of skin (about)	0.0
Weight	408
Displacement	484

GERMAN BRIDGE EQUIPAGE

As a comparison with the bridge data given [illegible] Austrian army engineers, it is interesting to note that the German engineers erect much more substantial pontoon bridges. Each regiment of German cavalry (Guards excepted) is assigned two pontoon wagons loaded with bridge material and tools and equipment for repair and demolition. The equipage carried with a cavalry division (four regiments) is supposed to be able to build the following bridges:

(a) NORMAL BRIDGE—One whole pontoon to each bay, using saddles; three-panel roadway, 157 ft. 6 in. long, 9 ft. 10 in. wide, able to carry cavalry in file, men leading horses; guns and wagons with two horses.

(b) LIGHT BRIDGE—Half pontoons alternating with pontoons, two-panel roadway, 221 ft. long, 6 ft. 3 in. wide, to take cavalry in file.

(c) FOOTBRIDGE—Half pontoons, one-panel roadway, 325 ft. long, 3 ft. 4 in. wide.

The footbridge has little value as the men must separate from supplies ;it vibrates badly and the pontoons act badly even in mild currents. The light bridge is suited to short raids where no artillery is required. The main dependence, however, is placed in the normal bridge.

AUSTRIAN ENGINEER CORPS BUILDING A PONTOON BRIDGE OVER THE DANUBE RIVER

*From a report to the Board of Engineer Troops, by Capt. W. G. Caples, and published in "Professional Memoirs," March-April, 1914.

Partial Failure of Standley Lake Dam, Near Denver, Colo.

[*Contributed*]

The Standley Lake Dam, lying about 12 miles northwest of the City of Denver, Colo., has been reported by the daily press within the last few days to be in danger of failure, and an examination was made on Saturday, Aug. 1, 1914, by the State Engineer of Colorado, accompanied by Messrs. A. L. Fellows, W. M. Reynolds, conducted by John E. Hayes, Engineer of The Denver Reservoir Irrigation Co., with a view of ascertaining the extent of the failure, the possibility of further failure, and other matters, and the attendant danger.

The Standley Lake Reservoir was constructed for the most part between the years 1909 and 1911. It consists in the main of an earth embankment 7000 ft. in

length, and was constructed to a height of 113 ft. at the highest place, and tapering to nothing at the two ends of the embankment. It was constructed with slopes, 2 horizontal to 1 vertical, on each side, with two berms on the lower face. The two outlets are of concrete and appear at the present time to be in good condition. The material, which seems to be of rather poor quality, was for the most part placed from dumping cars, run lengthwise of the embankment upon high trestles, and does not appear to have been tamped, rolled or sprinkled or packed in any way, excepting by impact of the falling material. The trestles rest upon lines of piling along and parallel with the axis of the embankment. Settlement in the dam, since construction, has been very large, being apparently some 10% of the height of the dam. Water was impounded in the reservoir in 1913 to a depth of 79 ft. at the outlet, and in 1914 to a depth of 83 ft. The plane of saturation appears to be very flat, but investigations regarding this phase have not as yet been completed.

The upper face of the dam is riprapped with about 2 ft. of large boulders, shaped as broken from the quarry, and roughly laid by dumping. In general, it would not seem to have been very greatly affected by wave action, excepting in a few places, one of these places being opposite to the point where the partial failure has just occurred.

During the last week of July, 1914, a partial failure of the back of the dam near the center of the embankment occurred. About 300 ft. in length of the rear, one-half of the embankment bulged at the lower face to some extent, the line of breakage extending to the inner edge of the crest of the dam. The old line of trestle appears to have been pushed out for a distance of 10 or 15 ft. The management immediately ordered the water to be turned out from the dam, and the water has now been lowered from a depth of 83 ft. to a depth of 76 ft., and will be lowered to a depth of from 65 to 70 ft., at which depth of water there would appear to be no danger of further failure at the present time. Extreme care is being exercised, watchmen being kept constantly at the point of settlement as tremendous damage would be done to cultivated lands, railroads and houses lying below the dam.

The State Engineer, who is giving the matter his personal attention, has issued instructions as to what is to be done at once in connection with the matter. For the present it is safe to say that no damage to property lying below the dam is likely to occur, and the partial failure, while of great interest to the engineering profession, is not likely to result in damage to anyone other than the Denver Reservoir & Irrigation Co.

The Railway Rate Decision

The long expected decision of the Interstate Commerce Commission on the petition of the railways in the territory east of Chicago to advance their freight rates an average of 5% was made public on July 29, but the exciting events in Europe so diverted the attention of the newspapers that comparatively little publicity has been given to the decision. This is unfortunate, as it is one of the most important decisions ever handed down by the Commission. It is a lengthy document of over 100 pages, but its conclusions may be briefly summarized as follows:

The Commission assents to an advance in rates substantially equal to the amount asked for in what is known as Central Freight Association territory, which includes the region west of Buffalo and Pittsburgh, and east of the Mississippi River. The advance in freight rates are refused to the lines east of Pittsburgh and Buffalo. Commissioners McChord and Daniels filed dissenting opinions.

The Commission agrees that the railways have established that in many cases they are entitled to earn larger net profits from their business than they are now receiving. The Commission holds, however, that the way to secure these net profits is not by a horizontal increase in all freight rates but that the rates should be placed on a more just and scientific basis. Instead of advancing all rates, the rates should be advanced on those classes of traffic which are now clearly unremunerative.

The Commission further points out that the chief cause of deficient profits in the railway business is that passenger traffic is being carried at too low rates. It urges that steps be taken to separate passenger expenses from freight expenses in railway accounting, and expresses the belief that if the two-cent-a-mile laws are shown to be unjust to the railways, the public will acquiesce in amendment of these laws so that fares may be increased to a remunerative basis. The Commission further proposes that the railways investigate the expenses they now incur in furnishing various classes of free service in connection with freight shipment, together with the cost of soliciting freight and passenger traffic. The Commission finds that on 88 railways the expense of soliciting business in the year ending June 30, 1913, was $4,298,000.

Among other suggestions of the Commission as to the methods by which the railways can increase their revenues are a further reduction in the issue of passes, a study of methods for increasing freight-car efficiency, and methods of economizing in fuel and in other large items in operating expenses.

Two other suggestions of the Commission which point very closely to the recent revelations in connection with the New Haven system and the St. Louis & San Francisco are, first, the proposition that railways should sell all the properties they now hold that they cannot use for transportation purposes. The railways in the territory to which the report refers have invested more than $684,000,000 in such property, and about one-fourth of this investment returned no income whatever last year. The second suggestion is as follows:

> We suggest that an investigation be made with a view to determining to what extent the cost of construction or of acquiring properties or capital or of operation is being increased through the holding by directors, officers or employees of interests with other concerns with which the carrier has dealings.

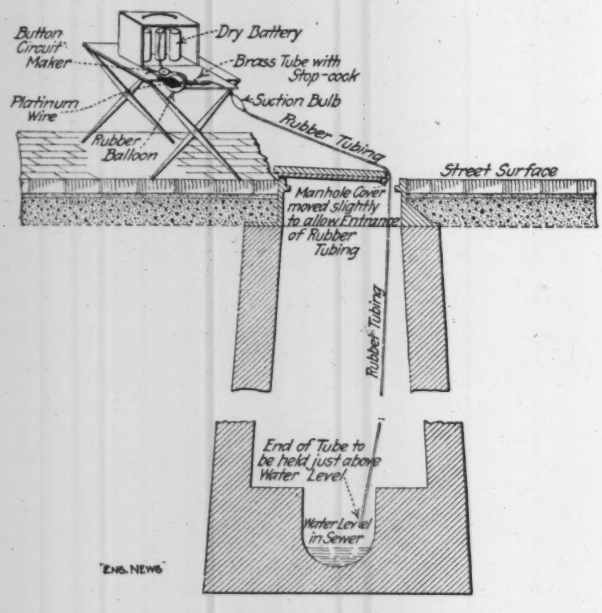
The plain intimation here is that the operating expenses of railways are being increased in some cases through the existence of graft in connection with the purchase of supplies or the acquirement of property. That there is some ground for this assertion recent investigations have proved. The Commission announces that it is itself conducting an independent investigation of this matter.

The most important point in the whole decision is the explicit recognition of the Commission that the railways are entitled to charge rates high enough to earn a fair return on the capital invested, provided, of course, that the properties are honestly and efficiently managed.

It is doubtful, whether there will be another petition for a general horizontal advance in rates. In view of the opinion of the Commission now given, the problem of increasing rates must be solved by attacking the matter in detail and by following out to a considerable extent, where practicable, the suggestions of the Commission.

Simple Apparatus for Testing Sewer Air for Explosive Mixtures*

Experiments made by Prof. A. L. Dean, of Yale University, have proved that an explosive mixture may



APPARATUS FOR TESTING SEWER AIR FOR EXPLOSIVE MIXTURES, DEVISED BY PROF. A. L. DEAN, YALE UNIVERSITY

be made of only one part of gasoline to 15,000 parts of air by volume; or 1 gal. of gasoline to 2000 cu.ft. of air. This shows how small an amount of gasoline in a sewer may cause serious damage if ignited.

Prof. Dean has designed a simple, ingenious and apparently practical device for testing the air in sewers, without sending a man into the sewer to obtain a sample of the air. This apparatus is shown in the accompanying sketch. The apparatus is to detect gasoline vapor, which is heavier than air, lighter illuminating gas may be detected by odor at the top of the manhole, although the apparatus will show if there is enough to form an explosive mixture.

A long rubber tube is let down into the manhole, through a small opening left by just starting off the cover, after sounding for depth to find the length of tube necessary to reach nearly to the surface of the stream. The bulb is worked until both the rubber tube and bulb are filled with sewer air. Then a small collapsed rubber toy-balloon is slipped over the firing end of the short piece of brass tubing, to which the long rubber suction tube is attached.

Projecting from the brass tube into the balloon are the ends of two insulated wires from the dry-battery cells, the wire ends being connected by a fine platinum wire. When the balloon is well filled with sewer air by pumping with the bulb, the stop-cock in the brass tube is shut, to prevent backfiring, and the electric circuit is closed by pressing a button. The heated platinum wire explodes the balloon if the sewer air is of an explosive mixture.

*Abstracted from a recent report by Henry J. Kellogg, Assistant City Engineer, New Haven, Conn., on "Explosions in Sewers."

Analyses of Tubercles from the Interior of a Cast-Iron Water Main*

Samples of tubercles from the cast-iron pipe which enters the High Hill Reservoir gatehouse of the New Bedford, Mass., water-works, were collected and analyses of the soft central or middle portion thereof and of the tubercles as a whole were made. Results of these analyses are as follows:

ANALYSES OF TUBERCLES—Sample marked No. 3, soft central portion of tubercles from 48-in. cast-iron pipe:

Silica and insoluble matter	3.24%
Ferric oxide Fe_2O_3	69.12
Alumina and lime Al_2O_3 and CaO	Traces
Sulphuric anhydride SO_3	1.36
Water of hydration H_2O	26.28
Carbon dioxide CO_2	None

Sample marked No. 4, whole tubercle from 48-in. cast-iron pipe as above:

Silica and insoluble matter	1.78%
Ferric oxide Fe_2O_3	68.62
Alumina and lime Al_2O_3 and CaO	Traces
Sulphuric anhydride SO_3	0.55
Water of hydration H_2O	28.16
Carbon dioxide, CO_2	None

The accompanying illustrations show photographs of some of these tubercles, removed during the inspection of the pipe in May, 1913. The same pipe was inspected five years previously, in May, 1908. During that period, the tubercles had grown considerably in size. The extent of this growth is best indicated by the four outer rings, which can be clearly seen in the illustrations, showing the under or contact side of the tubercle.

*From recent annual report of the Water Board of New Bedford, Mass.

NEWS NOTES

A Broken 20-In. Water Main in New York City flooded the subway excavation on 7th Ave. at 23d St., at 1 p.m., Aug. 3.

An Auto Truck Wrecked a Timber Bridge over the Pennsylvania Canal near Morrisville, Penn., on July 29.

An Explosion in a Cable Manhole of the Edison Electric Illuminating Co., of Boston, on July 27, blew off the manhole cover.

A Water-Supply Standpipe Collapsed into a reservoir, in Sublette, Ill., on July 18, flooding adjacent streets. The standpipe was full at the time.

The Flooring of a One-Deck Porch built near the ground collapsed while crowded during a thunderstorm, on July 29, at Keyport, N. J.

The Effects of European War are seen in the recent decision of the Southern Power Co., and the Piedmont & Northern Ry. Co. (allied), not to let the contracts announced for July 5, and amounting to several hundred thousand dollars. It is reported that the plans for a fourth auxiliary steam plant (15,000 hp.) will be held up, although some contracts have been let.

Projects of the city of New York to the extent of $50,000,000 are reported indefinitely postponed. This includes the New York County court house ($20,000,000), the Kings County court house ($2,500,000), the South Brooklyn marginal freight railway ($12,000,000), and various other improvements. While general retrenchment is planned, it is announced that rapid-transit subway and dock-improvement work under way will be carried forward with as little interference as possible.

A Sewer Explosion at 23d St. and Seventh Ave., New York City, on July 27, hurled a manhole cover into the air and sent a column of flame upward. A section of wood-block pavement was ripped up. Sand was used to extinguish the fire in the sewer.

A Locomotive Boiler Exploded on the Erie R.R., near Corning, N. Y., killing the engineer and fireman and injuring another man, on July 31. At about the same time, a tube blowout occurred on an Erie locomotive at Montclair, N. J., injuring the engineer and fireman.

A Cloudburst Flooded Telluride, Colo., on July 27. In the business district, 120 stores were sunk in 8 to 20 ft. of mud; many residences were wrecked. The town is situated in a canon. A dam which retains the water supply for the town was destroyed. Two persons were killed.

Ten Large Forest Fires were reported on July 27 in western Montana and northern Idaho. One of the fires, which was started by campers near the Hearst Lake reservoir, which furnishes Anaconda, Mont., with water, heavily damaged the timber area to the west of the lake.

A Construction Elevator Collapsed at the three-story extension to the Dixmont Hospital, Pittsburgh, Penn., recently, injuring seven workmen. The contractor stated that the men had no right on the hoist and had been instructed to keep off. The fall was claimed to have been not over 14 ft.

The "Incemore" Was Held Responsible for the collision, on June 17, with the North German Lloyd steamship "Kaiser Wilhelm II," by the British Admiralty Court, on July 17. Sir Bargrave Deane in rendering his decision said he found that the "Incemore" had made a mistake in giving a signal that she had stopped when as a matter of fact she had not done so.

A Tow-Barge Demolished a Steel Bridge Span of the Dover bridge over the Choptank River, about 4 mi. from Easton, Md., on July 17. The tug "Rescue," of Baltimore, with two barges in tow, loaded with stone, and bound for a wharf above the bridge, attempted to pass through the open draw, on a strong flood tide. One of the barges struck the bridge, breaking off a number of wood piles, which caused a 70-ft. steel span to drop in 40 ft. of water.

A Gate Accident on the Welland Canal, in which the two headgates of Lock No. 8, St. Catherines, Ont., were carried away by the steamer "Sarnor," of the Lake Erie & Quebec Transportation Co., of Montreal, while upbound to Ashtabula for coal, at about 10:45 a.m., on July 27, delayed navigation for about 10 hours. The rush of water carried the vessel and the gates out into the reach below. The level above No. 8 is short, while the level below is a mile long, consequently practically no water overflowed and there was no washing away of the banks. It will be necessary to place two spare gates before navigation can proceed. The damage is estimated at about $4000. The accident was caused by the engineer putting the vessel ahead in response to a signal to reverse the engines. A 1¼-in. cable was snapped before the gates were struck.

Retired Municipal Employees to the number of about 8000 drew pensions from New York City last year, the total amount of money paid out in pensions being about $4,000,000. The size of the pensions varied all the way from $50 to $6000.

A New Proposal for the acquisition of the Spring Valley water system has been reported made by the city of San Francisco. The City Advisory Water Committee proposes purchase at $34,000,000, the company keeping the larger part of its Pleasanton lands, but giving the right to draw unreservedly on the subterranean waters, and holding its Lake Merced lands except for a marginal strip sufficient to prevent pollution. The company also would be reimbursed for outlay on Calaveras dam. Settlement of the Spring Valley rate case is included.

The Installation of Automatic Sprinklers for fire protection may be compelled by the Fire Department of New York City, according to a decision of the New York Court of Appeals. A property owner refused to install a sprinkler system in his loft building when ordered to do so by the Fire Commissioner. The case was carried to the Court of Appeals, which has affirmed the decisions of the lower courts, sustaining the authority of the Fire Commissioner to order such protective devices installed. It is stated that over 100 orders for the compulsory introduction of sprinklers in New York were on file awaiting the decision in this case.

The McClintic-Marshall Claim on the Panama Lock Gates has been referred by Congress to Col. George W. Goethals, Governor of the Canal Zone, for investigation. Colonel Goethals is to report his findings in detail to Congress. As noted in "Engineering News," Mar. 26 and Apr. 9, 1914, pp. 704, 806, the McClintic-Marshall Construction Co., of Pittsburgh, Penn., who built and erected the steel lock gates for the Panama Canal, recently presented to Congress a bill for extras on this work, amounting to about $2,400,000. Its principal claim was that a grade of workmanship had been enforced in the inspection that was far more costly to execute than the workmanship described in the specifications, and that went beyond any demands of efficiency.

New Mole for San Francisco Bay—A contract for the construction of a mole to replace the trestle now being used by the Key Route System, in San Francisco Bay, was awarded on July 27 to the San Francisco Bridge Co., for an estimated price of $475,000. When this work is completed, the mole will be 100 ft. wide and 11,000 ft. long. There are 1,100,000 sq.ft. of surface to be filled in to a height of 6 ft. above high tide. The average depth is 18 ft. At the end of the land mole there will be a wharf, set on creosoted piles, which will extend an additional 4200 ft. out into the bay toward San Francisco. The company sought the right to fill in under this wharf, but the United States authorities denied them the privilege. The company will make the entire stretch a stone and earthen fill as soon as authority from the government can be obtained.

Automatic Block Signals on the Pennsylvania R.R.—On Sept 1, with the completion of an elaborate plan of improvements in its automatic block-signal system, the Pennsylvania R.R. will have more four-track line operated under automatic signals than any other railroad in the world. At a cost of $6,000,000 in the past three years, 253 miles of main lines have been equipped. By Sept. 1, the main line between Pittsburgh and New York and Philadelphia and Washington will be equipped. The signal system on this road, east of Pittsburgh and Erie, represents an estimated investment of approximately $18,000,000, of which $1,750,000 is in the electro-pneumatic interlocking switch and signal system in the New York station and on the electric line between Sunnyside Yard, L. I., and Manhattan Transfer, N. J. It takes a normal force of 1800 men to maintain the road's signals and it costs $1,500,000 a year.

Fast Trains on English Railways have been reviewed in the engineering supplement of the London "Times," with lists of the various fast schedule runs. Of 62 runs from London, the highest record is 59.4 m.p.h. for 107 miles. The lowest is 36.2 m.p.h. for 730 miles, part of this being over unfavorable lines in the Highlands of Scotland. There are 21 of 45 to 50 m.p.h., 27 of 50 to 55 m.p.h., and 14 of 55 to 60 m.p.h. The three longest nonstop runs were from London to Plymouth (Great Western Ry.), 226 mi. at 54.8 m.p.h.; to Rhyl (London & Northwestern Ry.), 209½ miles at 52.7 m.p.h., and to Shipley (Midland Ry.), 206 mi. at 50.4 m.p.h. There were nine nonstop runs of over 100 miles. The fastest runs, however, were not from London; Darlington to York (Northeastern Ry., 44¼ miles), 61.7 m.p.h.; Leicester to Nottingham (Great Central Ry., 22½ mi.), 61.3 m.p.h. The following table is a list of the 14 fastest runs from London in 1913:

City	Railway	Miles	Time Hr.	Time Min.	Speed
Bath	Gt. Western	107	1	48	59.4
Bristol	Gt. Western	118½	2	00	59.1
Exeter	Gt. Western	174	3	00	57.8
Oxford	Gt. Western	63½	1	7	56.8
Leicester	Gt. Central	103	1	49	56.7
Leicester	Midland	99¼	1	45	56.5
Birmingham	London & N. W.	113	2	00	56.5
Nottingham	Midland	123¼	2	12	56.1
Worcester	Gt. Western	120½	2	9	56.0
Sheffield	Gt. Central	164¾	2	57	55.8
Liverpool	London & N. W.	192¼	3	28	55.4
Birmingham	Gt. Western	110½	2	00	55.2
Salisbury	London & S. W.	83½	1	31	55.1
Plymouth	Gt. Western	225¾	4	7	54.8

Bridge Building Prosperity in Iowa—Iowa counties have let a million dollars' worth of bridge contracts since Jan. 1. They will let contracts for probably half a million more before the end of the year. These figures cover only the work which has been contracted at public lettings. They do not cover the small work that has been let privately. They do not cover any part of the bridges and culverts the 99 coun-

ties are building by day labor. Engineers in close touch with the situation estimate that the day labor work and the small private contract work will total at least another million dollars for the first half year. In 42 counties no public lettings have been held. These counties are either doing all their work by the day labor system or are completing work contracted for last year. Several counties have held two lettings and contemplate others.—[From the July "Service Bulletin" of the Iowa State Highway Commission.]

PERSONALS

Mr. Thomas Turnbull, M. Can. Soc. C. E., of Winnipeg, Man., has been appointed Assistant Chief Engineer of the Canadian Northern Ry.

Mr. W. K. Winterhalter, of the firm of Berry & Winterhalter, Consulting Engineers and Agriculturists, San Francisco, Calif., has been appointed Consulting Agriculturist of the Spreckels Sugar Co., San Francisco.

Mr. C. R. Hubbard has resigned as President and General Manager of the Wheeling Steel & Iron Co., Wheeling, W. Va., in order to retire from active business. He has been the managing head of the company since 1892.

Prof. R. E. Chandler, Dean of the engineering division of the Oklahoma Agricultural and Mechanical College, has resigned his position to became Head of the Mechanical Engineering Department at the New Hampshire College, Durham, N. H.

Mr. Samuel S. Webber, M. Am. Soc. M. E., has resigned as Chief Engineer of the Trenton, N. J., plant of the American Steel & Wire Co. Mr. Webber was connected with the Trenton Iron Co. before it became a part of the American Steel & Wire Co.

Mr. John L. Billard, of Meriden, Conn., widely known for his connection with the transactions by which the Boston & Maine R.R., was acquired by the New York, New Haven & Hartford R.R., has resigned as Director of the New York, New Haven & Hartford R.R. and the New England Navigation Co.

Prof. R. H. Danforth, for the past six years with the U. S. Naval Experiment Station and the post graduate department of engineering of the U. S. Naval Academy, has been appointed Professor of hydraulics and mechanics at Case School of Applied Science, Cleveland, Ohio.

Mr. Charles E. Bright, Assoc. M. Am. Soc. C. E., for the past six years with the U. S. War Department in local charge of the construction of the Colbert Shoals Canal, Tennessee River, has been appointed Assistant Field Engineer, Division of Valuation, Interstate Commerce Commission, Southern District, with headquarters at Chattanooga, Tenn.

Mr. A. S. Ackerman, Assoc. M. Am. Soc. C. E., Senior Assistant Engineer, Cape Cod Construction Co., builders of the Cape Cod Canal, has been promoted to be Resident Engineer, succeeding Mr. Charles T. Waring, Assoc. M. Am. Soc. C. E., who has been appointed Superintendent of Operation, as noted elsewhere. Mr. Ackerman was educated at the Massachusetts Institute of Technology and has been on the Cape Cod Canal work for several years.

Mr. Charles T. Waring, Assoc. M. Am. Soc. C. E., recently Resident Engineer in charge of construction of the Cape Cod Canal, has been appointed Superintendent of Operation of the canal, with headquarters at Sandwich, Mass. Mr. Waring succeeded Mr. H. W. Durham, M. Am. Soc. C. E., now Chief Engineer of the Bureau of Highways, Borough of Manhattan, New York City, in 1912; previous to that he was Division Engineer of the canal. The Chief Engineer is Mr. William Barclay Parsons, M. Am. Soc. C. E., Consulting Engineer, New York City.

OBITUARY

Charles H. Cooke, a retired Civil Engineer, whose experience dated back to the building of the Union Pacific R.R., died at his home in New York City, Aug. 1, aged 67 years. For several years he was connected with the engineering staff of the Long Island R.R. He is survived by a widow.

William E. Clark, for several years associated with the Rail Joint Co., New York City, died July 5, at Charlestown, N. H. He was born in 1847 in Manchester, N. H. At the age of 16 years he enlisted in the United States Navy and served three years during the Civil War. Following the war he went into railway bridge work. Later he was road-master of the Connecticut division of the Boston & Maine R.R., which position he held for nearly 25 years. He joined the staff of the Rail Joint Co. of America in 1897 and has traveled extensively for the company for many years.

Dr. John Galbraith, Past-President, Can. Soc. C. E., dean of the faculty of applied science and engineering at Toronto University, Toronto, Ont., died July 22, at his summer home on Georgian Bay. He was born in Montreal in 1848 and graduated at Toronto University in 1868. After graduating, he engaged in railway work, and in 1878 became Professor of engineering in the Ontario School of Practical Science, of which he was appointed Principal. In the early days of that institution, Dean Galbraith taught all the branches of engineering himself, and in the face of great difficulties succeeded in building up the school to the position it at present occupies. When it became affiliated with the university, Dr. Galbraith was appointed Dean of the faculty of applied science. He was one of the three commissioners appointed to investigate the collapse of the Quebec Bridge in 1907. Dr. Galbraith was one of the founders of the Canadian Society of Civil Engineers, and in 1908 was elected President of the society. Among other honorary positions which he held were the Vice-Presidency of the Engineering Section of the British Association for the Advancement of Science and the Vice-Presidency of the Engineering Section of the American Association for the Advancement of Science. [A more complete biography and a portrait of Dr. Galbraith were published in "Engineering News" of Feb. 6, 1908, at the time of his election to the presidency of the Canadian Society of Civil Engineers.]

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS.
Aug. 20-21. Annual meeting in New York City. Secy., E. H. Harman, Room 101, Union Station, St. Louis, Mo.

AMERICAN PEAT SOCIETY.
Aug. 20-22. Annual meeting at Duluth, Minn. Secy., Julius Bordollo, 17 Battery Place, New York City.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION.
Sept. 1-4. Annual convention in New York City. Secy., J. D. Farasey, E. 37th St., and Erie Ry., Cleveland, Ohio.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 7-10. Annual meeting in New York City. Secy., H M. Wilson, Bureau of Mines, Pittsburgh, Penn.

NATIONAL ASSOCIATION OF PORT AUTHORITIES.
Sept. 8-10. Annual convention in Baltimore, Md. Secy., Wm. Joshua Barney, 29 Broadway, New York City.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 8-11. Annual meeting at Chicago, Ill. Secy., L. C. Ryan, Sterling, Ill.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 8-11. Annual convention in Nashville, Tenn. Secy., A. P. Dane, Reading, Mass.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 9-11. Annual convention in Boston, Mass. Secy., Willard Kent, Narragansett Pier, R. I.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 15-18. Convention in Atlantic City, N. J. Secy., Clayton W. Pike, Electrical Bureau, Philadelphia, Penn.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 21-25. Annual convention in Cleveland, Ohio. Secy., Joseph D. Israel, 29 W. 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Sept. 22-24. Annual convention in Bluff Point, N. Y. Secy., C. C. Rosenberg, Times Building, Bethlehem, Penn.

American Society of Agricultural Engineers—The annual meeting of the Society will be held in Madison, Wis., Dec. 28-30. The preliminary program has just been issued. The Secretary is F. M. White, Madison, Wis.

National Paving Brick Manufacturers' Association—The 11th annual meeting will be held at Buffalo, N. Y., Sept. 9-11, with headquarters at the Statler Hotel. The business meeting will be held on the first day, while on Sept. 10 and 11 sessions will be held on "A Study of Brick Pavement Construction for Country Highways." These sessions will include a trip for the inspection of city and county highways, and another to Niagara Falls. The Assistant Secretary is H. H. MacDonald, 830 Brotherhood of Locomotive Engineers Building, Cleveland, Ohio.

American Public Health Association—The annual meeting of the Association will be held in Jacksonville, Fla., Nov. 30-Dec. 5. The Secretary is Prof. S. M. Gunn, 755 Boylston St., Boston, Mass.